4 Exploration & Development

GOVERNMENT'S POLICY

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

* Judicious exploitation and utilisation of the country's mineral potentialities; carry out systematic regional and detailed exploration using state-of-the-art techniques in a time bound manner; emphasis on zero-waste mining and raise this endeavour as a national goal; and upgrading of mining technology in order to ensure exploration and utilisation of entire run-of-the-mine.

* To make regulatory environment conducive for private investment; procedures for grant of mineral concessions, such as Reconnaissance Permits, Prospecting Licences and Mining Leases shall be made 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 processes.

* With a purpose to attract large investments and innovative technology, a new concession, namely, Large Area Prospecting Licence (LAPL) would be introduced. Simultaneously, 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 encompass 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 areas of survey and exploration of minerals.

The High Level Committee constituted by the Government of India which brought out the National Mineral Policy, 2008 had 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.

Subsequently, the Mines and Minerals (Development and Regulation) Amendment Act, 2015 has been notified on 27th March, 2015 in supersession to the existing MMDR Act, 1957. The Amendment removes discretion 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 as compared to earlier provisions of 30 years. Thereafter, all mining leases 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. Further, in light of the amendments in MMDR Act an emergent need to

provide an impetus to exploration in the country has prompted a thorough review of exploration policy and strategy. A new exploration Policy namely, National Mineral Exploration Policy (NMEP), therefore, has been formulated and adopted in 2016.

ORGANISATIONS INVOLVED

GSI, AMDER, 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 2016-17.

The Oil and Natural Gas Corporation (ONGC) and Oil India Limited (OIL), the two National Oil Companies (NOC) and a few private and joint venture companies were engaged in exploration and production activities of oil and natural gas, including Coal-bed Methane in the country.

IBM

Indian Bureau of Mines (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 2016-17 (up to October, 2016), 79 multi - mineral lease hold maps on a scale of 1:50,000, with corresponding forest overlays in respect of various states were under finalisation.

To encourage value addition and mineral conservation, IBM conducted 23 ore dressing investigations, chemical analysis in respect of 18,239 samples, and 1,332 mineralogical examinations.

Sustainable Development Framework was rolled out at Sukinda Chromite Mine of TISCO in Odisha in January 2016. Star Rating of mines under SDF was notified by Ministry of Mines in May 2016. Online evaluation templates for star rating of mines was launched by the Hon'ble Minister of Mines. SDF star rating templates for online filing was uploaded on the web portal and the validation was in progress.

IBM 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 and updating of NMI as on 1.4.2015 has been completed for all 71 minerals.

GSI

GSI pursued its most fundamental and basic mapping programme of systematic geological mapping in 2016-17 and had completed 8043.10 sq km large-scale mapping, 145.63 sq km detailed mapping and 1,39,071.98 m drilling as against preceding year's achievement of 5924.95 sq km large-scale mapping, 106.03 sq km detailed mapping and 113,202 m drilling. Out of the total mappable areas of 3.146 million sq km of the country, 3.106 million sq km has been covered so far by systematic mapping bringing the total coverage to 98.73%.

Rsources Established

Resources augmented by GSI during 2016-17 are given below:

i) A total resource of 51.11 million tonnes high grade iron ore (Cut off 55% Fe) with average Fe content of 61.13 % has been estimated. Besides, low grade (45-55% Fe) resource of 9.44 million tonnes with average 49.64% Fe has also been estimated in Gandhalpada South-East, Part -A, Kendujhar district, Odisha.

ii) A total resource of 23.87 million tonnes of high grade iron ore (Cut off 55% Fe) with average Fe content of 61.99 % has been estimated. Besides, low grade (45-55% Fe) resource of 5.0 million tonnes with average 50.04% Fe has also been estimated in Rengalaberha North-East Block, Kendujhar district, Odisha.

iii) Iron ore resource of 1.81million tonnes with average 44.79% of Fe has been established up to 15m depth in notified Block 4B/C116/MMM 2003 of Kumaraswamy Hill Range, Ballari district, Karnataka.

iv) Estimated iron ore resources in Pachchudaiyanpalaiyam Block are 7.391 million tonnes. In Kariyampatti Block, it is 7.296 million

tonnes and in Ulipuram Block, it is 4.779 million tonnes. Hence,
the total resources of low grade iron ore in the study area are 19.466 million tonnes with an average of 26.25% Fe content over an average width of 6.36m in the BMQ between Namagiripettai and Tammampatti, Namakkal and Salem district, Tamil Nadu.

v) The estimated inferred iron ore resources (Fe<25%) of BIF band in Yerragunta sub-block are 1.03 million tonnes (cross section method) and 0.97 million tonnes (LV section method) in notified blocks in Khammam and Warangal districts, Telangana.

vi) Estimated 1.202 million tonnes of iron ore resources with an average grade of 33.127% (total Fe) under reconnaissance category in Sitanagaram - Macherla Block Khammam Schist Belt, Warangal district and in Lachhapuram Block, Pakhal Basin, Khammam district, Telangana.

vii) A resource potential of 0.395 million tonnes of gold ore with grade ranging from 0.9 to 4.17 g/t and width ranging from 0.5 to 3 m could be estimated in Paramanahalli Central and North Blocks, Chitradurga district, Karnataka.

viii) The ore resource has been calculated by Cross Section (CS) and Longitudinal Vertical Section (LVS) methods, based on all boreholes drilled in the area. Total in situ resource is 1.75 million tonnes with 0.42% Cu by Longitudinal Vertical Section (LVS) method and 1.72 million tonnes with 0.42% Cu by Cross Section (CS) method with 0.20% Cu cut off and 1.70 million tonnes with 0.42% Cu by CS method at 0.3% cut-off in North of Golwa, Mahendragarh district, Haryana.

ix) In north of Tosham hill, Bhiwani district, Haryana, the resources have been estimated at 8.16 million tonnes of Tin at 0.21% Sn, 4.08 million tonnes of tungsten at 0.29%W, 18.10 million tonnes of copper at 0.38% Cu and 0.23 million tonnes cobalt with an average grade of 0.16% Co.

x) The resource of the cement grade limestone is estimated at 29.14 million tonnes with CaO value <42% and SiO_2>17% in Tadutla block, Guntur district, Andhra Pradesh.

xi) The resources of cement grade limestone of Chintalayapalle block are estimated at 33.14 million tonnes in CAK block, Kurnool district, Andhra Pradesh.

xii) A total of 221.90 million tonnes inferred category of lignite resources has been estimated which includes 80.63 million tonnes of lignite 'A' grade and 141.27 million tonnes of lignite 'B' grade (between a depth range of 371.00 to 463.40m) in Kalari North Sector, Ramanad sub-basin Ramananthapuram district, Tamil nadu.

Survey

Marine Survey

GSI continued its offshore geoscientific studies both in Exclusive Economic Zone (EEZ) and Territorial Waters (TW) of India. Survey in the near-shore zones i.e. 0 m to 10 m isobaths was carried out using hired mechanical boats.

Marine and Coastal Survey Division (M&CSD) has completed seabed mapping of 1,37,520 sq km out of 1,50,000 sq km in 5 km × 2 km grid within Territorial Water and 18,55,614 sq km out of 18,64,900 sq km in the Exclusive Economic Zone beyond Territorial Waters on reconnaissance scale. Total EEZ coverage including TW is 19,93,134 sq km out of a total EEZ area of 20,14,900 sq km. In addition, an area of 1,164 sq km within the contiguous zone was mapped on reconnaissance scale with sampling grid of 5 km x 2 km.

During the field season, R.V. Samudra Ratnakar covered an area of 41,234 sq. km by high resolution seabed mapping by multi beam bathymetry and 31,134 sq. km for mineral investigation. Under different themes, R.V. Samudra Ratnakar collected 12,549 LKM single beam bathymetry, 5,275 LKM magnetic, 16,550 LKM gravity, 2,538 LKM multichannel seismic, 15,587 LKM sub-bottom profile and 15 Conductivity-Temperature-Depth (CTD) profile data, 21 ROV data and also sediment samples and water samples from 262 stations. During 2016-17, a total of twenty three cruises was undertaken using three vessels. i.e. 9 cruises of R.V. Samudra Ratnakar, 7 cruises of R.V. Samudra Kaustubh and 7 cruises of R.V. Samudra Shaudhikama.

The following marine geoscientific surveys were carried out during 2016-17 Field Season:

R.V. Samudra Ratnakar

1. SR-023: Study of morphology and tectonic set up of Northeast Andaman Sea within EEZ of India..
2. SR-023A: Special cruise mounted for Indian Navy in search of missing IAF_AN-32 Aircraft.
3. SR-019: Study of tectonic set up of Bay of Bengal and Andaman-Nicobar subduction complex

within EEZ of India by systematic multi-channel seismic survey.

RV Samudra Kaustubh

1. ST-251: Study of seabed morphology by seimic and magnetic survey within Territorial Waters off Visakhapatnam - Pudimadaka, Andhra Pradesh coast, Bay of Bengal

2. ST-254: Systematic magnetic survey within Territorial waters in the shelf area between Paradip and Shortt's Island, Odisha.

3. ST-256: Study of seabed morphology of the shelf off Palar river mouth, Tamil Nadu by swath bathymetric survey.

4. ST-257: Study of seabed morphology by Seismic and Magnetic survey within Territorial Waters off Chennai-Point Pudi, Tamil Nadu Coast and the Bay of Bengal.

RV Samudra Shaudhikama

1. SD-270: Seabed mapping off Mahuva, Gujarat(block-III) beyond Territorial Water of India.

2. SD-271: Mapping of seabed off Diu, Gujarat beyond Territorial Water of India.

3. SD-272: Mapping of seabed off Pipavav, Gujarat, beyond TW of India.

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, crustal structure, etc.

During 2016-17, the airborne surveys by Twin Other Airborne Survey System (TOASS) were carried out in the Alwar-Neem Ka Thana area in parts of Rajasthan, Haryana & Uttar Pradesh and over the Marwar – Khetri area in parts of Rajasthan & Haryana. The surveys in both the areas were conducted by engaging magnetic and radiometric sensors.

a) Alwar-Neem Ka Thana area in parts of Rajasthan, Haryana & Uttar Pradesh: Aerophysical survey has been conducted through TOASS over Alwar-Neem Ka Thana area in parts of Rajasthan, Haryana & Uttar Pradesh with an objective to identify potential areas for mineral investigation. The study area is surrounded by different blocks which were already covered by airborne surveys. The preliminary data of unprocessed aeromagnetic show high frequency anomalies which is indicative of causative sources of shallow nature as seen towards northern part of the area around Shahpur, Chomu and Dausa where several base metal prospects have been reported by GSI.

b) Marwar – Khetri area in parts of Rajasthan & Haryana: A total of 37,645 line km of magnetic and radiometric data has been collected covering an area of 43,048 sq km through TOASS. The Magnetic anomalies of the area are significant as there are base metal occurrences reported from Biramsar area.

Heliborne Geophysical Survey

The heliborne survey was conducted over Shimoga area, Karnataka with an objective to delineate potential areas for gold occurrences and PGE mineralisation within Shimoga Schist belt. The surveyed area covered 2,683 LKM over an area of 593 sq km. The radially averaged power spectrum analysis of magnetic anomaly has shown presence of two crustal magnetic interfaces at depths of about 320 and 1460 m. Electromagnetic signal map shows possible zones of mineralisation.

MECL

The highlights of exploration carried out by MECL during 2016-17 are given below:

i) The company has carried out 5.19 lakh meter of exploratory drilling for various minerals, out of which 4.23 lakh meter was through departmental resources and 0.96 lakh meter from outsourcing.

ii) A total of 235 sq km area has been covered with detailed geological mapping for various minerals in different parts of the country. In addition to this about 2,170 sq km of regional geological mapping has also been carried out in various minerals block exploring through NMET funding and also carried out 2.45 lakh meter of geophysical logging.

iii) In laboratories, a total of 70,570 samples was analysed for chemical analysis and mineralogical analysis; petrographic and ore microscopic studies.

iv) A total of 38 geological reports of detailed exploration for different minerals was submitted which led to addition of 3,184 million tonnes of

mineral resources.

v) During 2016-17, a total of 3,184 million tonnes of mineral resources was established. Mineral-wise details of reserves estimated by MECL are as under:

• Coal - A total of 1.534 million tonnes of coal resources was established in Mand-Raigarh, Surajpur & Bisrampur Coalfield, Chhattisgarh, Ib river valley Coalfield, Odisha and Singrauli Coalfield, Madhya Pradesh.

• Lignite - 172 million tonnes of lignite resources were established in Tamil Nadu.

• Iron Ore - 204.92 million tonnes of iron ore resources were established in Sandur Schist Belt, Ballari and Chitradurga Schist belt, Tumakuru district in Karnataka.

• Copper - 4.412 million tonnes of copper resources were established in Thanewasana, Chandrapur district, Maharashtra.

• Molybdenum - 0.70 million tonnes of molybdenum resources were established in Uttangarai sector, Dharampuri district in Tamil Nadu.

• Gold - 2.45 million tonnes of gold ore resources were established in Chitradurga Schist Belt,Tumakuru and Nuggihalli Schist Belt, Hassan district in Karnataka.

• Limestone - 1,265 million tonnes of limestone resources were established in Litang River Vally, Jaintia Hills district in Meghalaya and Satna district in Madhya Pradesh.

MINERAL-WISE EXPLORATION ACTIVITIES
PETROLEUM AND NATURAL GAS

A number of new initiatives have been taken to promote Exploration and Production activities in the country. A multi-dimensional approach has been adopted for furthering the objective of enhancing energy security of the country through increased domestic production and improved investment climate in the country. Some of the policy initiatives taken by the Government for exploration and development of oil and gas in the country are as under:

The operator can explore and produce conventional as well as unconventional hydrocarbon such as Coal Bed Methane(CBM), Shale etc under a single license.

Opening up of India's sedimentary basins through open acreage policy will provide option for the companies for selection of Exploration blocks. They will also not be required to wait till the formal bid round is launched by the government as the open acreage area will be available throughout the year for bidding.

Exploration will be allowed through-out the contract period. One of the major restrictions under Production Sharing Contract (PSC) was regarding exploration after the completion of exploration phase. The Hydrocarbon Exploration Licencing Policy (HELP) addresses the same and allows exploration throughout the contract period.

Exploration Phase for onshore areas have been increased from 7 years to 8 years and for offshore increased from 8 years to 10 years.

As on 31.3.2016, there were in all 427 oil/gas fields under these companies in the country including offshore areas.

As per policy guidelines, ONGC Ltd. and Oil India Ltd have to carry out Shale Gas and Oil exploration in 50 and 05 blocks respectively for assessment under Phase-I. ONGC is carrying out Shale Gas and Oil exploration activities in Cambay, Cauvery, Krishna-Godavari and Assam & Arakan Basins. ONGC has drilled 21 wells and 83 cores have been collected in 21 wells. During 2016- 17, ONGC has completed coring and other data collection programme in three wells in Cambay basin in different blocks. These data will help in assessment of the shale gas and oil potential of respective blocks. Oil India Limited is carrying out Shale Gas and Oil exploration activities in Assam and Rajasthan basins. Oil India Ltd. (OIL) has initially identified five Blocks viz. Dibrugarh, Chabua, Dumduma, Jaisalmer and Jairampur from its Nomination acreages and later on identified one more block (Deomali PEL) and started G&G evaluation. OIL has completed G&G evaluation of four Blocks i.e, Dibrugarh PML, Chabua PML, Dumduma PML and Jaisalmer PML. Out of 55 blocks, 3 blocks operated by ONGC and 4 blocks operated by OIL are in the state of Assam.

During the year 2016-17, ONGC has made 23 oil and gas discoveries in domestic fields (operated by ONGC). Out of the 23, 13 discoveries are in onshore areas & 10 in offshore areas. 12 discoveries were made

in the new prospects whereas 11 were new pool discoveries. Of the above 23 discoveries, 4 discoveries have been made in NELP blocks. Nine of these discoveries have already been put to production. The ONGC also drilled 100 exploratory wells with good hydrocarbon exploration success. Notably, with Jabera discovery, ONGC has brought Vindhayan Basin into the oil & gas reserve map of India.

Under Nomination regime, ONGC and OIL are operating 15 Petroleum Exploration Licence (PEL) and 358 Petroleum Mining Lease (PML) blocks covering an area of about 99,719 sq km. Basin wise, OIL operates 27 PML/PEL covering an area of 6235.76 sq km of Rajasthan basin - 2 PML and Assam-Arakan basin - 5 PEL & 20 – PML whereas ONGC operates 347 PML/PEL covering an area of 93484.03 sq km of Assam-Arakan basin – 5 PEL & 62 PML; Cambay basin – 160 PML; Cauvery basin – 32 PML; Himalaya Foreland basin – 1 PEL; Krishna Godavari basin – 1 PEL & 49 PML; Kuchchh basin – 1 PEL & 2 PML; Mumbai basin – 2 PEL & 26 PML; Rajasthan basin – 5 PML and Vindhyan basin – 1 PML. Besides, Private/JV companies are operating 81 PEL and 55 PML blocks covering 1,29,137 sq km area.

During 2016-17, cumulative 14,624 LKM 2D offshore seismic data was acquired, mostly of which was carried out under PSC regime by Private companies/ JVs. 7,825.29 sq km of 3D seismic data was acquired in Onland and 5,822.98 SKM 3D seismic data was acquired in offshore area. Majority of 3D data was generated by ONGC in its nomination areas. Total 141 exploratory wells (including onland and offshore) were drilled for a cumulative meterage of 3,92,309 m.

National Oil Companies (NOCs)/PSUs have generated 4,403 LKM in 2D seismic, 11,686 sq km in 3D seismic and drilled 131 exploratory wells, whereas private companies have generated 14,838 LKM in 2D seismic, 1,962 sq km in 3D seismic and drilled 10 exploratory wells in 2016-17.

The ultimate reserve (2P) accretion of oil and oil equivalent gas (O+OEG) in 2016-17 in domestic assets of ONGC was 64.32 million tonnes.

During 2016-17, total 37 hydrocarbon discoveries were made with 29 in nomination regime and 8 in PSC regime.

During 2016-17, Oil India Ltd has carried out 3D seismic survey and acquired 277 sq km of 3D seismic data in 7 exploratory wells. OIL carried out 63.80 thousand meter drilling in 19 exploratory wells and 105.44 thousand meter drilling in 37 development wells in onland area.

The area wise development drilling wells & meterage drilled by ONGC, OIL and private/joint ventures during 2016-17 are given in Table -1.

Details of the discoveries made by ONGC and Oil India Ltd are given in Table -2.

SHALE GAS

Exploration for assessing the shale gas/oil prospectivity has been initiated in 4 basins of the country viz., Cambay, KG, Cauvery and A&AA Basins as per the policy guidelines notified by Government of India (GoI) for exploration and exploitation of shale gas and oil by National Oil Companies (NOCs). ONGC has identified 50 nomination PML (Petroleum Mining Lease) blocks under Phase-I. As on 31.03.2017, 22 assessment wells (5 exclusive shale gas and 17 dual objective wells) in 19 PML blocks have been drilled in Cambay, KG, Cauvery and A&AA

Table - 1: Area-wise Development of Wells & Meterage Drilled by ONGC, OIL & Private/ Joint Ventures , 2016-17

Agency	Onshore		Offshore		Total	
	Wells (Numbers)	Meterage (in'000)	Wells (Numbers)	Meterage (in'000)	Wells (Numbers)	Meterage (in'000)
(A) ONGC (Nomination)	266	493.05	86	221.87	352	714.92
(B) OIL (Nomination)	37	105.44	-	-	37	05.44
(C) Private/JVs	9	21.21	-	-	9	21.21
Total	**312**	**619.69**	**86**	**221.87**	**398**	**841.56**

Source: *Director General of Gas & Hydrocarbons Annual Report 2016-17.*

Basins and the required data are being generated/ evaluated for shale gas/ oil assessment. During the year, 4 dual objective wells in Cambay basin have been drilled.

COAL BED METHANE (CBM)

Out of 9 CBM Blocks awarded to ONGC, five blocks viz. Satpura (Madhya Pradesh), Wardha (Maharashtra), Barmer-Sanchor (Rajasthan), North Karanpura (West) and South Karanpura (Jharkhand) have been relinquished due to poor CBM potential. ONGC is operating in four CBM Blocks i.e. Jharia, Bokaro and North Karanpura in Jharkhand and Raniganj in West Bengal.

Table - 2: Oil & Gas discoveries made by ONGC and Oil India Ltd during 2016-17

Name of Basin	Well Name	Name of ML	Oil / Gas
A. ONGC			
Gujarat Kachchh	GKS101NCA-1	GK-OSN-2010/1[NELP- IX]	Gas
Krishna Godavari	KGS092NASRI-1	KG-OSN-2009/2[NELP - VIII]	Oil
Saurashtra Offshore	MBS051NAA-2	MB-OSN-2005/1[NELP-VI]	Gas
Cambay Basin	NDDA (Nadiad # 4)	CB-ONN-2001/1[NELP-III])	Oil
Cambay Basin	Akholjuni-29	Akholjuni PML	Oil
Cambay Basin	Dahej-20	South Dahej PML	Gas
Cambay Basin	Olpad-47	Olpad-Dandi-Extn-I PML	Gas
Cambay Basin	Gandhar-724	Gandhar Ext-XII PML	Oil & Gas
KG Onshore	Kesanapalli West Deep-1	Adavipalem- Ponnamanda PML	Oil & Gas
KG Onshore	Thurupu Vipparu-1	Godavari Onland PML	Gas
KG Offshore (SW)	GS-71-1	GS-15 & 23 PML	Oil & Gas
KG Offshore (SW)	G-1-N-2	Vasishta PML	Oil & Gas
Mumbai Offshore	B-34-2	South & East Bassein PML	Oil
Mumbai Offshore	B-154N-1	BOFF PML	Oil & Gas
Mumbai Offshore	B-157N-1	BOFF PML	Oil & Gas
Mumbai Offshore	D-30-2	BOFF PML	Oil & Gas
Western Offshore	B-12C-2	C' Series ML	Gas
Vindhyan Basin	Jabera-4	Nohta-Damoh-Jabera PML	Gas
A&AA Basin(South Assam Shelf)	Suphayam-2	Golaghat District PEL	Oil
A&AA Basin (South Assam Shelf)	Dayalpur-1	Kasomarigaon (Additional) PML	Oil & Gas
A&AA Basin (South Assam Shelf)	Nambar-12	Nambar PML	Gas
A&AA Basin (South Assam Shelf)	(KHBB_Z) Khoraghat-38_Z	Nambar PML	Oil & Gas
A&AA Basin (North Assam Shelf)	Geleki-390	Namati PML	Oil &Gas
B. Oil India LTD			
Upper Assam Onshore	HJN055	Hugrijan PML	Oil
Upper Assam Onshore	NHK606	Hugrijan PML	Oil
Upper Assam Onshore	HJN062	27 Hugrijan PML	Oil & Gas
Upper Assam Onshore	NHK595	Nahorkatiya Extension PML	Oil
Upper Assam Basin	HJN067	Dumduma PML	Gas
Upper Assam Basin	NHK637	Hugrijan PML	Oil & Gas
Upper Assam Basin	KRJ001	Tinsukia PML	Oil
Upper Assam Basin	BHB001	Hugrijan PML	Oil
Upper Assam Basin	MKM043	Hugrijan PML	Gas

***Source**: Director General of Gas & Hydrocarbons, Annual Report 2016-17.*

COAL

The agencies engaged in exploration for coal during 2016-17 were mainly GSI, CMPDI and MECL.

GSI

GSI continued its operations for search and assessment of coal resources in the country through regional exploration in coalfields of Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Madhya Pradesh, Odisha, Telangana and West Bengal.

In Arunachal Pradesh, a G4 stage reconnaissance survey was carried out in the Eastern parts of Namchik-Namphuk Coalfield, Changlang district. Geological mapping of an area of 50 sq km was mapped to delineate and assess the coal potentiality of the eastern extension of Namchik-Namphuk Coalfield, 5 coal seams have been recorded in this coalfield. The bands range from 0.5 to 6.0 m in thickness. The coal seam varies from <0.5 m in thickness to 6 m.

In Assam, a G3 stage preliminary exploration was carried out for Gondwana Coal in Khopati area, Singrimari Coalfield, Dhubri district, Assam at the border of Assam and Meghalaya.An area of 2.5 sq km around Bhordoba area was mapped on 1:10000 scale. A total of 600.50 m has been drilled in two boreholes in Khopati area. Coal/carbonaceous zone of 0.34 m thickness was intersected within the borehole at 213.78 m depth in first borehole. The second borehole has progressed up to 327.50 m.

In Bihar, a G2 stage general exploration was carried out for Gondwana coal under the cover of Younger formations in Gokulmathura Block Rajmahal groups of Coalfields, Bhagalpur district . A total of 19 sq km area has been mapped on 1:10000 scale. Total 5,373.30 m drilling has been achieved in 14 boreholes. Four coal seam zones viz. seam zone-A, B, C, and D have been established. The thickness of individual seam zone varies from 1.65 to 110.40 m within the depth range of 75.10 to 425.85 m. The total cumulative coal thickness encountered in 14 boreholes is 563.80 m.

A G2 stage general exploration was carried out for Gondwana coal under the cover of younger formations in Shrinagar Block north-eastern side of Hura north extension block, Rajmahal groups of Coalfields, Bhagalpur district. Shrinagar Block is being explored covering an area of 10 sq km under G-2 stage for establishing the continuity of coal bearing Barakar Formation. A total of 4,844.00 m drilling has been achieved in seven boreholes. Four coal seam zones viz. seam zone-A, B, C and D have been established.

In Chhattisgarh, a G2 stage exploration was carried out for coal in Jobro West Block, Mand-Raigarh Coalfield, in Raigarh district. Barakar Formation is the main repository of the regional coal seams and it represents a sequence of medium to coarse grained sandstone, heterolith, siltstone, grey shale, mudstone, carbonaceous shale and regional as well as local coal seams. Middle Barakar contains major regional coal seams of economic importance in the basin. A total of 2433.35 m drilling was done. Eight regional Barakar coal seams (Seam II, III, IV, V , VI+VII, VIII, IX & X in ascending order) and a few local coal seams within Raniganj Formation have been intersected between the depths of 15.39 m and 692.74 m. Thickness of individual coal seam varies from 0.57 m to 16.88 m. Strike wise 2.5 km and dip wise 2 km extension of all major coal seams have been traced over the area. G2 stage exploration was carried out for coal in Tendumuri Block, Mand-Raigarh Coalfield, in Raigarh district. Tendumuri Block located in the north-central part of the Mand-Raigarh Coalfield, is covered by the Barakar Formation. The middle part of the entire Barakar sequence contains major regional coal seams of economic importance in the basin. A total of 3495.10 m drilling was done in seven boreholes. Altogether, twelve regional Barkar coal seams (I to X, XII & XIII in ascending order) were intersected between the depth of 17.75 m and 626.34 m. Thickness of individual coal seam varies from 0.50 m (Seam X) to 13.36 m (Seam IV). Strike wise 3 km and dip wise 3 km extension of all major coal seams have been traced over the area. A total of 1674.26 m geophysical logging and 3 sq.km large scale mapping (RF 1:10000) has also been carried out. In Surguja district, a G2 stage Regional exploration was carried out for coal in Sendur block, Tatapani-Ramkola Coalfield. In Sendur Block, a total of 3408.10 m drilling was done. Four regional Barakar coal seams (Seam-I to III & Seam-XIII in ascending order) with thickness varying from less than a meter to 19.68 m (cumulative) have been intersected between the depths of 256.60 m and 644.74 m. Seam-III occurs in two splits i.e. Seam III Top and Seam III Bottom. It is the most important seam amongst all regional Barkar coal seams in terms of thickness and regional persistency.

In Madhya Pradesh, a G3 stage exploration for coal was carried out in Dhorakuhi sector, Pench valley Coalfield, in Chhindwara district. LSM of 3.0 sq. km is in Dhorakuhi Sector and a total of 1563.45 m drilling was carried out in four boreholes. Five regional Barakar coal seams (I to V in descending order) have been intersected between the depth ranges from 347.56 m to 409.03 m. The cumulative coal seam thickness is 12.92 m. Thickness of individual coal seam varies from 0.64 (Seam-II) to 5.05m (Seam-IV).

In Shahdol district, a G2 stage exploration for coal was carried out in Lamru block, Sohagpur Coalfield. A total of 2712.60 m has been drilled in nine boreholes. An area of 5 sq km was geologically mapped on 1:10000 scale during the period. Barakar Formation is the coal bearing horizon in the Lamru block of Sohagpur Coalfield. Four regional Barakar coal seams (I to IV in

ascending order) along with few local seams have been intersected within the depth of 105.85 m to 288.00 m with cumulative coal thickness ranging from 0.05 m to 7.55 m. In the western part of the area, regional Seam-III is the thickest and most persistent seam. However, Seam II has attained considerable thickness particularly in the southern part of the block and occurs as the thickest seam.

A G2 stage exploration for coal was carried out in Kirhai block, Sohagpur Coalfield, in Shahdol district. A total of 2698.85 m has been drilled. An area of 5 sq km was geologically mapped on 1:10000 scale. Mapping reveals that the major part of the block is covered with calcareous sandstone of Lameta Formation. Coal bearing horizon in Kirhai block is restricted within Barakar Formation. Three regional Barakar coal seams along with two local seams have been intersected within the depths of 135.40 m to 278.50 m with cumulative coal thickness ranging from 0.55 m to 5.70 m. Seam-II is the most important regional Barakar coal seam in terms of thickness and regional persistency.

In Singrauli district, a G2 stage exploration for coal was carried out in Pachaur Block, Singrauli Coalfield. Pachaur block is located in the north-eastern part of main sub-basin of Singrauli Coalfield in Singrauli district. The area is covered by rocks of Raniganj formation. Barren Measures are found to be 249.14 m to 278.40 m thick while Barakar Formation shows a maximum of 400.26 m thickness. The middle part of the entire Barakar sequence is the most important as it contains all the regional coal seams of economic importance in the basin. A total of 3132.20 m drilling was done. An area of 3 sq km has been covered by large scale mapping (RF 1:10000). The regional exploration has established development of four regional (R-I to R-IV) and a few local Raniganj coal seams. The thickness of coal seams ranges from less than a meter to 5.77 m. The dip extension of thicker coal seam (Seam R-II) has been established for a distance of about 3.5 km to 4 km. Barakar Formation contains thicker and important coal seams. Within Barakar Formation, seven regional (Seam I to VII) and a few local coal seams ranging in thickness from less than a meter to 13.90 m (Seam VI) were intersected between depth range of 407.96 m (Seam VII) and 763.98 m (Seam-I). Barakar Seam VI is the most important seam in terms of its thickness and regional persistency. The strike and dip extension of Seam VI has been established for a distance of about 4.5 km to 5 km and 2 km to 2.5 km respectively.

In Odisha, a G2 stage general exploration for coal was carried out in Kantaikoliya North Block, Talcher Coalfield, Angul district. An area of around 2 sq km was mapped on 1:10000 scale and a total of 1176.20 m was drilled in two boreholes. A total cumulative coal thickness of 54.44 m (depth range: 239.63 m to 518.85 m) and 44.62 m (depth range: 153.25 m to 441.37 m) have been intersected in the two boreholes completed. Ten regional coal seam zones of Barakar Formation have been established for 1 km in strike direction and 1.5 km along dip direction.The investigation will continue.

In Jharsuguda district, a G2 stage exploration for coal was carried out in Teteliabahal block, Ib river coalfield.Total 3 sq km area was mapped on 1:10000 scale and a total of 2716.30 m drilling was carried out in four boreholes including two are in progress. 304.17 m of Coal core samples were collected. Besides, geophysical logging of 1605 m was carried out. Four coal seams of Raniganj formation have been intersected between 89.33 m and 295.20 m depth. Four coal seams of Barakar Formation (Belpahar, Parkhani, Lajkura and Rampura) have been intersected between 280.89 m and 813.02 m depth. Lajkura seam zone having hightest cumulative thickness of 65.73 m and has regional persistence and thickness. The investigation will continue.In Sundargarh district, a G2 Stage regional exploration for coal was continued in Ustali Block, Ib-River Coalfield to establish the continuity of the regional Barakar coal seams intersected in Kulda-Manoharpur and Hemagiri areas of Ib River Coalfield. Total 2287.45 m drilling was done in five boreholes, 2954 m borehole geophysical logging was done and 599.28 m(cumulative) coal core samples were collected for proximate analysis. Four regional coal seam zones of Barakar Formation (Belpahar, Parkhani, Lajkura, Rampur from top to bottom) and one coal seam zone of Karharbari Formation have been intersected between 8.39 and 587.88 m depth. Amongst the Barakar coal seam zones, Rampur and Lajkura seam zones are important for their cumulative coal thickness, which varies from 68.29 m to 92.52 m and 39.31 m to 44.17 m, respectively. The maximum cumulative coal thickness of other seam zones i.e. Belpahar and Parkhani is 6.98 m and 21.12 m, respectively. Coal petrographic studies of representative samples depict the rank of coal is sub-Bituminous. Occurrence of 4 regional coal seam zones of Barakar and Karharbari formations up to a depth of 587.88 m from surface have been established. Amongst the Barakar, Rampur is the most important seam zone due to its cumulative coal thickness which varies from 68.29 m to 82.09 m intersected between 370.70 m and 587.88 m depth.

In Telangana, exploration of coal by drilling in Eastern Extension of Pagaderu (East) sector, Godavari Valley Coalfield, in Khammam district was taken up during field session 2015-16 and 2016-17 with an objective to explore and evaluate coal potentiality of Lower Kamthi and Barakar coal seams in the strike direction of the adjacent Pargaderu (East) sector. A total of 78.92 m of coal was sampled from the boreholes. Lower Kamthi Seams (V to I) intersected from a depth range of 63.46 m to 305.35 m with individual thickness from 0.50 m to 1.06 m. Barakar seams (A&B, No I seam, C and Thick seam) intersected from a depth range of 168.72 m to 745.47 m with individual seam thickness ranging from 0.50 m to 24-39 m. Coal proved along the strike extension of 4.5 km and dip extension of 1.5 km.

In West Bengal, a G2 stage general exploration for coal was carried out in Kherobari block, Raniganj coalfield, Bardhaman district. A total of 3158.00 m of drilling was achieved in 7 boreholes. Four Regional coal seam zones viz. R - VIII, R - VII R - VI & R-Basal developed within the depth range of 254.50 m to 610.30 m of thickness varying from 0.50 m to 2.90 m. One lignite seam of thickness 1.40 m has been intersected at the depth of 152.00 m. In Birbhum district, a G2 stage general exploration was carried out for Gondwana coal under the cover of Rajmahal formations in Buritala Block within Dholkatha-Garia area, Rajmahal-Birbhum Coaldfields. A total area of 5.0 sq.km has been mapped on 1:10000 scale. A total of 2426.80 m drilling has been drilled in five boreholes. Coal intersected at a depth range of 184.78 to 561.70 m in the Barakar Formation. The total cumulative coal thickness of the four completed boreholes was 319.41 m.

CMPDI

CMPDI continued its coal exploration activities in 2016-17, 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. A total of 140 to 160 drills was deployed in 2015-16, out of which 64 drills were departmental.

CMPDI deployed its departmental resources for detailed exploration of CIL/Non-CIL 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 2016-17, CMPDI and its contractual agencies took up exploratory drilling in 122 blocks/mines spread over 22 coalfields in six states. Out of 122 blocks/ mines, 35 were Non-CIL/Captive blocks and 87 CIL blocks/mines. Departmental drills of CMPDI took up exploratory drilling in 56 blocks/mines, whereas contractual agencies drilled in 65 blocks/mines.

A total of 11.256 lakh m of exploratory drilling was carried out by CMPDI in 2016-17 through departmental resources (4.414 lakh m) and outsourcing (6.842 lakh m) to State Governments/MECL/Tendering (CIL/Non-CIL blocks). Details of exploratory drilling carried out by CMPDI in 2016-17 are given in Table - 3.

LIGNITE

GSI

The details of investigation for lignite during 2016-17 by GSI are given below:

In Rajasthan, search for lignite was carried out by scout drilling in Charanwala North area in the Palana Basin, Jaisalmer and Bikaner Districts. A total of 3,816 m drilling has been carried out and 3,438.60 m was geophysically logged. Lignite has been intersected in 9 numbers of boreholes out of 12 boreholes with minimum roof depth 131.0 m and maximum floor depth 227.00m. The subsurface geology of the area comprises Nagaur Formation, Palana Formation, Marh Formation, Jogira Formation and Quaternary. Palana formation is the sole lignite repository horizon and comprises greyish greenish clay, siltstone, carbonaceous shale, etc.

In Tamil Nadu, a G3 stage preliminary exploration for Lignite was carried out in Kalari North Sector, Ramanad sub-basin in Ramananthapuram district. The explored area is located to the south of Bogalur East Sector and east of Tiyanur Sector in the East Coast Lignite Field, Tamil Nadu. The area is central part of Ramnad Sub-Basin located in the southern part of the Cauvery Basin. The investigation was initiated during field seasons 2015-2016 and continued in 2016-2017. A total of 11 boreholes have been drilled at a spacing range from 1 to 2 km for a total meterage of 5,020.55 m in the Kalari North Sector in an area of 27 sq km. Geophysical logging was carried out in nine boreholes. Single regionally persistent lignite seam which splits into three major seams (namely IA, IB & IC) of the previously explored Tiyanur Sector and Bogalur East Sector has been established. Cumulative thickness of lignite seams in boreholes drilled varies from 3.20 m to 15.00 m and intersected in a depth range of 371.00 m to 463.40 m with partings of cumulative thickness ranging between 3.00 m and 25.50 m. Lignite extends over a strike distance of about 7 km and about 6 km along dip direction in the Kalari North Sector. The quality of lignite in Ramnad sub-basin is comparable to the overall lignite quality of the Neyveli and Mannargudi Lignite fields. The average moisture content of the lignite is assumed as 45%. Analytical result of 60 samples generated from nine boreholes has been received. The weighted recalculated ash content lignite samples varies from 3.62 to 22.84%. The weighted recalculated volatile matter varies between 20.99 and 35.14% and fixed carbon content varies between 11.17 and 23.48%. The weighted calorific value ranges from 1,470.61 K. Cal/Kg to 3,543.30 K. Cal/Kg and about 50 % of band-by-band samples analysed shows a calorific value of more than 3000 K. Cal/Kg. A total of 221.90 million tonnes of "Inferred" category lignite has been estimated over an area of 23.194 sq.km which includes 80.63 million tonnes of lignite 'A' grade and 141.27 million tonnes of lignite 'B' grade have been estalished in Kalari North Sector between a depth range of 371.00 m to 463.40 m.

GMDC

GMDC, Gujarat continuously undertaking exploration activities to confirm the stratigraphy of the proposed mining area and behaviour of lignite and its resources. During 2016-17, GMDC carried out exploration in Tadkeshwar lignite lease area located near Tadkeshwar village, Mandvi Taluka, Surat district with an objective to know the exact boundary of lignite seams and re-assesment of reserves in north pit area (about 70 ha). An area of 21.13 ha was mapped on 1:5000 scale and external dump area of 19.72 ha on 1:3000 scale. Total 14 boreholes were drilled for a cumulative depth of 1200 m and collected 600 samples. Resources estimated under i) measured (STD 331) category - 40.00 million tonnes and ii) recoverable (STD 111) category - 33.90 million tonnes. The company has also established 18 million tonnes of additional lignite reserve in Mata-no-Madh area, Kachchh district, Gujarat.

NON-FERROUS METALS

BASE METALS

GSI and MECL conducted investigations for copper, lead and zinc ores in different parts of the country during 2016-17.

GSI

The details of exploration activities carried out by GSI during 2016-17 are given in Table-4.

MECL

Exploration for copper in Thanewasana block was taken up based on recommendations of GSI & MECL with an objective to i) define shape, size and geometry of ore body more preciscly, ii) firm up the data by drilling infilling boreholes to intersect ore body at shallow levels of 75 mRL and 25 mRL, iii) augment copper ore resources and grade with higher limit and examine possibility of gold at depth, iv) verify behaviour of ore body at deeper levels and v) collect bulk samples for conducting beneficiation studies. During G2 level exploration, MECL carried out large scale mapping of 0.697 sq km area on 1:1000 scale; Drilling of 14 boreholes for cumulative meterage of 3557.50 m; collected 882 nos of primary, check core samples for Cu, 184 nos primary samples each for Au and Ag, 21 nos of composite samples for Au and Ag, 21 composite samples for Cu, Co, Ni, Mo & W; 22 nos samples for trace elements, 29 nos samples for petrological studies, 40 nos samples for mineragraphic studies, 21 samples each for XRD and spectrographic studies, 47 nos samples for specific gravity determination and one sample for beneficiation. Total ore resources of 4.412 million tonnes with 0.84% Cu have been estimated at 0.50% cut off grade under indicated category of UNFC. This includes previous estimation made by various exploration agencies at different times.

HZL

A total of 74,800 m surface drilling was carried out during 2016-17. This drilling added gross reserves and resources of 26.4 million tonnes, having grade of 6.7% zinc, 2.2% lead and 79 g/t silver. Total ore resources as on 31.03.2017 of HZL stand at 404.4 million tonnes with 27.3 million tonnes of zinc metal, 8.80 million tonnes lead metal and 32,000 tonnes silver metal.

Table - 3: Exploratory Drilling by CMPDI (Departmental and Outsourcing) in 2016-17

Sl. No.	Agency	Target (lakh m)	Exploratory drilling achieved (lakh m)	Achieved (%)
1.	Departmental	4.000	4.414	110
2.	Outsourcing			
	i) State Govts.	0.060	0.005	5
	ii) MECL (MoU)	2.565	3.562	139
	iii) Tendering (CIL/Non-CIL Blocks)	4.375	3.274	75
	Total	**11.000**	**11.256**	**102**

Table - 4: Exploration for Base Metals by GSI, 2016-17

State/District	Name of block	Details of exploration	Results
Andhra Pradesh			
Kadapa	Around Zangamarajupalle	Mapping	G4 stage investigation (rcconnaissance survey) for basemetal mineralisation has been carried out by LSM on 1:12500 scale over an area of 158 sq km. Besides, 430 sq.km of reconnaissance survey was completed. The bands do not have any potential sulphide mineralisation.
Kurnool	Around Chetlamallapuram-Nayakallu area	Mapping, Drilling & Sampling	During G3 stage preliminary exploration, an area of 2.0 sq km has been mapped on 1:2000 scale in three different blocks to establish the presence of the base metal and other associated mineralisation and demarcate the size and shape and determine the grade of the ore bodies and assess the resource. Total four boreholes were drilled covering 570 m in the Nayakallu blocks. The borehole spacing was maintained at 100-200 m for three boreholes in Nayakallu East block and one borehole drilled in Nayakallu old working block. All four boreholes were planned to intersect the mineralised zone at 60 m vertical depth. The SEM and EPMA studies revealed gold, molybdenite, bismathinite, chalcopyrite, pyrite, thorite, allanite minerals in borehole core section. The values of 131 BRS range from 10 – 16500 ppm Cu, 25 – 40 ppb Au, 5 – 301 ppm Nb and 0.5 – 333 ppm Ta. Total 87 no. of APKN-1 borehole core samples show 10-2600 ppm Cu, 25 – 600 ppb Au, 5-31 ppm Nb, 0.2-25 ppm Ta. In PTS the values range from 10-275 ppm Cu, <25 ppb Au, 0.2-124 ppm Nb, 0.09-54 ppm Ta and in SS it ranges from 10-7700 ppm Cu, 25-38 ppb Au, 5-52 ppm Nb, 5.8 – 110 Ta respectively.
Haryana			
Bhiwani	North and West of Tosham around Khanak-Ratera-Kirwar-Jamalpur area	Mapping, Geophysical survey & Sampling	During G4 stage reconnaissance survey for multi-metal deposit, an area of 185 sq.km was mapped on 1:12500 scale. Surface sampling carried out across the strike from the exposures of quartz feldspar porphyry and pink porphyritic granite. Bedrock samples were collected and analysed for Cu, Sn, W, Au, Ni, Co, Pb and Zn. Detailed geophysical investigation carried out over 73 line km for locating multi metal deposits in and around area. On the basis of the geophysical corroboration, probe for possible mineralisation at a vertical depth has been recommended.
	North of Tosham hill	-	During G2 stage exploration for multi-metal deposit, mineralised zone stretching over 880 m strike length with individual band thickness varying from 2 m to 19 m has been explored in the area. The resources has been estimated to be 8.16 million tonnes Tin at 0.21% Sn, 4.08 mt tungsten at 0.29% W and 18.10 mt copper at 0.38% Cu. Cobalt, which was not reported earlier in this mineral belt, has a resource of 0.23 mt with an average grade of 0.16%.

(Contd.)

Table - 4 (Contd.)

State/District	Name of block	Details of exploration	Results
Base Metal (Copper)			
Mahendragarh	North of Golwa	Mapping, Drilling	A G2 stage general exploration for copper mineralisation in north of Golwa was taken up by detailed mapping of 0.30 sq.km on 1:2000 scale. A total 2125.15 m drilling was done in seven boreholes over a cumulative strike length of 1000 m. It is observed that a single lode is intersected in all boreholes. The thickness of the zone varies from 3.2 m to 14.25 m. Total in situ resource estimated in the area is 1.75 million tonnes with 0.42% Cu by LVS method and 1.72 million tonnes with 0.42% Cu by CS method with 0.20% Cu off and 1.70 million tonnes with 0.42% Cu by CS method at 0.3% cut-off.
Mahendragarh	NNW of Islampur village	Mapping, Drilling & Sampling	During G2 stage preliminary exploration for copper mineralisation, detailed mapping on 1:2000 scale covering 1.00 sq.km area was carried out alongwith 961.95 m drilling in five boreholes. A total of 180 nos. core samples from boreholes were analysed for Cu, Pb, Zn, Sn and W. Analytical results show - 20 to 1476 ppm Cu, 41 to 1413 ppm Zn, 20 to 1612 ppm Pb, 20 to 36 ppm Sn and 20 to 225 ppm W. Analytical results of four samples each of channel and pit samples showed <10 ppm Cu, <10 ppm Pb and 11-30 ppm Zn. No mineralised zones could be established on the surface.
	Gangutana (Block-1 of Zone-A)	Mapping & Drilling	During G2 stage general exploration for copper mineralisation in Gangutana (Block-1 of Zone-A), detailed mapping on 1:2000 scale covering 0.50 sq.km area was taken up along with drilling in 15 boreholes. On the basis of borehole data and chemical results, the four mineralised zones (with 0.2% cut-off of copper) have been identified viz. Zone-I ranging in thickness from 5.00 m to 26.5 m, Zone-II from 3.50 m to 24.50 m, Zone-III from 10.00 m to 30.00 m and Zone IV 14.00 m.
Karnataka			
Chitradurga	Ingaldhal sulphide zone	Sampling	G4 stage reconnaissance survey for Ingaldhal sulphide zone for polymetallic mineralisation in this area has been carried out, followed by sampling.The mineralisation in the area is noticed within the BIF bands of regional extent, mostly at locations of structural complexity such as fold hinges and sheared contacts. The disseminated sulphides were also observed within BIF and metabasalt devoid of any structural traps and discordant veinlets. No gold was observed in native state megascopically and the major sulphides identified associated with the mineralisation are pyrite, chalcopyrite and bornite. The exact extent of mineralisation can only be assessed after receiving all the analytical results.The available analytical results for bedrock sample shows Au value ranges from <25 to 170 ppb, Cu value ranges from <10 to 65 ppm, Zn values ranges from 25 to 400 ppm, Ni value ranges from 20 to 100 ppm, Cr value ranges from 40 to 250 ppm. In trench samples the Au value ranges from <25 to 102 ppb.
Madhya Pradesh			
Betul	Biskhan block	Drilling & Sampling	During G2 stage exploration for basemetals mineralisation, a total 300 m strike length of potential zone was take up by drilling 11 boreholes for a cumulative length of 1589.80 m. Nine boreholes intersected sulphide mineralisation. Sulphide mineralisation occurs in the form of dissemination, streaks, stringers and thin films of pyrite, sphalerite and occasional chalcopyrite. The visual estimate varies from 1% to 2% sulphides. Analytical results of 2 boreholes shows presence of a 29.5 m thick Zn zone with average 1.43% Zn at 1% cut-off.

(Contd.)

Table - 4 (Contd.)

State/District	Name of block	Details of exploration	Results
Basemetals			
Madhya Pradesh			
Betul	Ghisi block, Betul belt	Drilling	During G2 stage general exploration for basemetals and associated polymetallic mineralisation, a total 500 m strike length was taken up by drilling 13 boreholes for a cumulative length of 1972 m. The main host rock for sulphide mineralisation is garnetiferous quartz – muscovite – biotite – chlorite schist. The sulphide mineralisation occurs in the form of disseminations, specks streaks, stingers and thin bands of pyrite and sphalerite along with occasional chalcopyrite. The mineralisation is not uniform is patchy in nature. Visual estimate shows 1 to 1.5% sulphides with some patches of 2 to 3% sulphides in some boreholes. The chemical analysis of boreholes indicates the presence of one or two zone with average 0.71% X 4.35 m zinc, 0.2% X 5.0 m, 0.37% X 2.20 m, 1.07% X 9.18 m and 0.57% X 12.40 m.
Chhindwara	Jangaldheri block, Betul belt	Drilling	Total of 400 m strike length was taken up for G2 stage general exploration for base metal mineralisation and 6 boreholes were drilled comprising a total of 1025.6 m drilling. All boreholes intersected sulphide mineralisation. Visual estimate shows sulphides vary from 1 to 1.5%. The chemical analysis of borehole indicates presence of two to four zones of zinc enrichment of 0.050% X 1.12 m, 0.59% X 2.49 m, 1.21% X 2.24 m, 1.40% X 9.14 m, 0.69% X 1.87 m, 0.67% X 4.88 m, 0.55% X 3.00 m and 0.54% X 13.62 m.
Copper			
Maharashtra			
Chandrapur	Minjhari area	Mapping, Drilling	G3 stage preliminary exploration for establishing copper and associated mineralisation in Minjhari area was carried out by detailed geological mapping of 0.75 sq km area and drilling. Seven boreholes with cumulative drilling of 1233.80 m was completed in south and central block of Minjhari. All the boreholes were planned at 120 m vertical depth of intersection and 200 m strike spacing. Four Boreholes have successfully intersected primary mineralised zone. Based on the chemical analysis of core samples from different boreholes, mineralised lodes are demarcated. The loads are of varying grades (0.20 to 0.50% of Cu) and thickness (2.0 to 16.65m) with a maximum of 4.26% Cu over 1.05 m width. The gold concentration in different boreholes is also erratic in nature and varies from 25 to 420 ppb.

(Contd.)

Table - 4 (Contd.)

State/District	Name of block	Details of exploration	Results
Copper and associated metals			
Rajasthan			
Alwar	Angari block Thanagazi Teh.	Mapping, Drilling & Sampling	During G4 stage investigation for copper and associated precious metals, a total 1.5 sq.km area was mapped on 1:2000 scale. On the basis of surface indications, four mineralized zones have been delineated. First zone is in the western part of the block within dolomitic marble having strike length 250 m and width varying from 15 to 35 m. Other three zones are present in the eastern part of the block with widths varying from 8 to 20 m and strike lengths varying from 60 to 145 m. The analytical results of channel samples show 5 m zone of average 0.24% Cu, 3 m zone of average 0.2% Cu, 1 m zone of 0.18% Cu and 1m zone of 0.17% Cu in the western part of the block. In the eastern part analytical results of channel samples show occurrence of zinc, i.e. 6 m zone with average 0.2% Zn. Subsurface exploration involving 565 m of drilling in three scout boreholes was carried out in Angari block. Boreholes were drilled at central part of the block intersected three Cu lodes and each one having 2m width with 1.19%, 0.36% and 0.31% Cu value at 0.2% Cu cut off. The other borehole was drilled in dolomitic marble at the western part and it intersected two Cu lodes with 0.2% Cu value at 0.2% Cu cut off. The lodes have 3.5 m and 2 m width, respectively. The Angari block has been recommended for further investigation.
	Bisoni block Thanagazi Teh.	Mapping, Drilling & Sampling	During G4 stage reconnaissance survey for copper and associated precious metals, a total 1.25 sq.km area was mapped on 1:2000 scale by detailed mapping alongwith drilling of 3 scout boreholes and sampling. Surface evidences of mineralisation are manifested in the form of malachite stains, presence of fresh sulphides like bornite, covellite, chalcopyrite, pyrrhotite, arsenopyrite and also in the form of old workings. A total of three scout boreholes with 567.50 m were drilled, which intersected sulphide mineralistion in the form of specks, disseminations, vein filling, fracture filling and occasional massive bornite, covellite, chalcopyrite, arsenopyrite and pyrrhotite. Pitting and trenching were carried out to establish the strike continuity of mineralisation. The first borehole intersected cumulative thickness of 13.5 m Cu lode with 0.22% Cu at 0.2% Cu cut off along with Au value at 46.50 m to 47.0 m and 48.50 to 49.50 m thickness as 0.13 ppm & 0.10 ppm, respectively. The second borehole intersected cumulative thickness of 14 m Cu lode with 0.23% Cu at 0.2% Cu cut off. The Mise-la masse survey carried out in two boreholes indicates both north and southward strike continuity of the mineralised zone. The Bisoni block have been recommended for further investigation.
	Mundiyawas Block, Mundiyawas-Khera area,	Mapping, Drilling & Sampling	G3 stage preliminary exploration for copper and associated precious metals in this area has been carried out by drilling, sampling & pitting. Six boreholes with 1504.85 drilling, collections core samples, pitting & trenching cum channel samples were done and the samples were analysed to evaluate potential of copper and associated precious metals mineralisation in Mundiyawas Block. Besides, petrological samples were collected, EPMA samples and XRD samples were collected and studied.One borehole intersected cumulative thickness of 18.95 m Cu lode with 1.21% Cu at 0.2% Cu cut off along with associated silver and gold (Three Au lodes of 6.65 m cumulative thickness with 3.0 g/t Au and three Ag lodes of 7.60m cumulative thickness with 11.44 g/t Ag). The zone includes a lode of 12.75m thickness with 1.63% Cu at 0.5% cut-off. Another borehole intersected two lodes of cumulative thickness of 26.15m with 0.32% Cu at 0.2% Cu cut off.

(Contd.)

Table - 4 (Contd.)

State/District	Name of block	Details of exploration	Results
Copper, Lead, Zinc, Bismuth and Tungsten			
Rajasthan			
Ajmer, Bhilwara & Udaipur	Badnor area	Mapping & Sampling	G4 stage reconnaissance survey for copper, lead, zinc, bismuth and tungsten mineralisation was taken up. An area of 148 sq km was mapped on 1:10000 scale. Malachite stain was observed in dolomite and oxidized/ limonitic stain in cherty quartzite. Out of the chemical results received one bedrock sample yielded 0.14% Zn, 280 ppm Co and 180 ppm Ni in the NW of Baiyawas. Bedrock samples yielded Bi values ranging from 23 to 975 ppm in the NW of Dungarkhera and tungsten values ranging from 314 to 461 ppm in the north of Badnor.
Copper and Iron			
Banswara	Talwara-Kushalpur area	Mapping & Sampling	G4 stage reconnaissance survey for copper and iron mineralisation was taken up. A total area of 126 sq km has been mapped by large scale mapping on 1:12500 scale along with systematic sampling. The central-west & central part of the area is chiefly occupied by the marble, impure marble and dolomite and exhibit the evidences of mineralisation in the form of extensive ferruginisation, limonitisation, brecciation, few patches of malachite stains and the long old working zone with more than 15 opening starting from south of Kewaria in the south running up to north of Bhamriatalai in the north of around 6.5 km strike length. Occurrences of manganese bearing pyrolusite and psilomelane have been noted in old workings. One sample has yielded presence of Hollandite in XRD analysis.
Copper			
Bhilwara	Kamalpura (NE) block Pur-Banera belt	Mapping & Sampling	G3 stage preliminary exploration was carried out. Total 805.0 m drilling was carried out in four boreholes. Core samples, BRS (channel samples) and petrological samples were collected for base metal analysis. Chalcopyrite, pyrite and pyrrhotite with occasional bornite grains are the sulphide minerals. All the four boreholes drilled have intersected copper mineralisation. Three copper lodes at 0.20% Cu cut-off and 1.50m stoping width are intersected in first borehole (i) 141.0-147.0 m thickness with 0.56% Cu, 151.0- 156.50 m thickness with 0.58% Cu and (iii) 176.0- 184.50 m X 0.35% Cu.The mineralisation is in the form of specks, disseminations, stringers and veins.The drilling results indicate that copper mineralisation continues to occur towards north of the main Kamalpura block.
	Kamalpura block Pur-Banera belt	Mapping & Sampling	G2 stage general exploration was carried out. Total nine boreholes were drilled for a cumulative depth of 2074.0 m. The five first level boreholes were drilled up to a depth of 200±10 m in between earlier drilled boreholes to ascertain the strike continuity of the copper mineralisation. The second level boreholes were drilled up to a depth of 250+ m. Core samples, BRS and petrological samples were collected for base metal analysis. Chalcopyrite, pyrrhotite and pyrite with occasional bornite grains are the sulphide minerals present in the area. All the nine boreholes intersected mineralised area and the chemical analytical results show a total 35 lodes of copper mineralisation. The mineralisation are in the form of specks, disseminations, stringers and veins.

(Contd.)

Table - 4 (Contd.)

State/District	Name of block	Details of exploration	Results
Basemetal, Tin, Gold, Tungsten and Molybdenum			
Bhilwara	Kanti-Haziwas-Devtalai-Paroli area	Geophysical survey, Mapping & Sampling	During G4 stage reconnaissance survey, a total of 118 sq.km area on 1:10000 scale has been mapped along with generation of bed rock samples and trench samples for geochemical analysis. The analytical results show only 10 nos. of samples have above 1,000 ppm Cu value ranging from 1,000 to 19,000 ppm with an average 4,864 ppm. It has been observed that all these higher values shown by sample from quartz vein from Devtalai-Gudaliay area shows copper value ranges from 5 to 850 ppm with an average 137.68 ppm. The analytical results show zinc value ranges from 5 to 1400 ppm with an average of 147.91 ppm. Analytical result of tungsten (W) shows an average of 123.08 ppm and value ranges from 0.50 to 566.24 ppm. The tungsten value is normally higher in quartz veins, pegmatite and garnetiferous mica schist in northern part of area. The REE analytical results of the samples show that the total REE value ranging from 0.20 to 556.52 ppm with average 105.05 ppm. The LREE analysis result shows values ranging from 0.62 to 496.15 ppm and HREE value ranging from 0.69 to 52.62 ppm.
Lead, Silver and Gold			
Sawai Madhopur & Bundi	Chauth Ka Barwara-Aligarh area	Geophysical survey, Mapping & Sampling	During G4 stage reconnaissance survey, Large Scale Mapping (1:10000 scale) of 115 sq km was carried out. Evidences of sulphide mineralisation were observed in the form of crystals of pyrite, galena and specks of chalcopyrite and bornite. Ground geophysical survey of 21 LKM show some interesting responses of moderate SP, low resistivity, high IP chargeability values and are indicating of probable zone of mineralisation. Bedrock (206), pitting/trenching (41) and petrochemical (26) samples were collected. Analytical results of 188 nos. of samples were received so far. Two samples from the ferruginised zone analysed 0.27% and 0.13% Pb. The analytical results of remaining samples are awaited
Copper			
Jhunjhunu	SW of Bansiyal village	Mapping & Sampling	During G4 stage reconnaissance survey, an area of 1.59 sq km on 1:2000 scale has been mapped. Different types of samples including chip/groove, pitting/trenching samples and grab samples were also collected. Vein type chalcopyrite and pyrite mineralisation noticed in the impure marble and micaceous quartzite. The partial analytical results of grab samples collected from the area have shown the anomalous values of copper ranging from 0.1% to 1.3%.

(Contd.)

Table - 4 (Contd.)

State/District	Name of block	Details of exploration	Results
Basemetal			
Sikar	Southern extension of Toda-Ramliyas block	Mapping & Sampling	During G4 stage reconnaissance survey, the area was mapped on 1:2000 scale along with collection of bed rock samples, channel and trenching/pitting samples. On the basis of presence of malachite staining and fresh sulphides, a mineralised zone of 1.2 km strike length with width of about 10-50m has been delineated on the surface. The analytical results of grid bedrock (50 x 10 m) samples indicate encouraging copper values ranging from 10 to 4300 ppm. Channel samples have been analysed for basemetal. Some of the channel samples show encouraging values to the range of 10 ppm to 0.21% Cu.
Copper and associated precious metals			
Sikar	Extension block of Bhudoli-Basara area, Nim Ka Thana	Mapping & Sampling	During G4 stage reconnaissane survey, an area of 1.5 sq km was mapped on 1:2000 scale and surface geochemical evaluation was done by collecting BRS, channel sampling, PS, ORM, XRD and EPMA samples for assessment of basemetal mineralisation and associated precious metals in the area. Occurrences of chalcocite and bornite as dissemination have been recorded. Two mineralisation zones have been demarcated in the area. The width of Zone I is about 5-100 m and strike length is about 1.5 km. The width and strike length of Zone II are about 15 -20 m and 300 m, respectively. Six channels have been laid across the mineralised zone. Bedrock samples show anomalous values of Cu of 0.11% to 0.33%.
Basemetal			
Sikar	Dhabala Block Kharabinjpur area	Drilling & Sampling	During G3 stage preliminary exploration, a total of 973.0 m of drilling has been carried out in six boreholes, varying in length from 197 m to 127 m below ground level to test the depth persistence and potential of basemetal mineralisation in the area along the 1.1 km strike length. The first two boreholes, located at two ends of the mineralised zone, were planned along channel with average Cu 0.35%, 18 m thickness and with average Cu 0.21%, 2 m thickness, respectively. In first borehole, three mineralised zones have been intersected as 23.60 m thickness of 0.51% Cu, 9.0 m thickness of 0.29% Cu and 21.0 m thickness of 0.43% Cu. The host rock containing copper mineralisation is mostly impure dolomite marble. Core samples have been submitted for sulphur isotope, fluid inclusion, geotechnical, petrography, XRD and EPMA studies.

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Table - 4 (Contd.)

State/District	Name of block	Details of exploration	Results
Copper and associated metal			
Sikar	Dariba North block	Drilling & Sampling	G2 stage general exploration has been carried out. Previously during G3 stage exploration (FS-2012-14) in the area, three mineralised zones (MZ-I,II & III) were identified. Explored 2 km long and 10 to 18 m wide mineralalised zone-I and estimated 2 million tonnes copper resources with average grade of 0.27% Cu. Ten first level boreholes and five second level boreholes and one deeper borehole have been drilled. The surface indication of mineralisation is mostly observed as malachite and azurite stains in impure banded dolomitic marble. The main sulphide minerals observed are chalcopyrite, bornite, chalcocite, pyrite, pyrrhotite and covellite. Chemical analysis of the borehole core sample received so far, shows copper lodes of 12 m, 6 m, 6 m & 3 m, 2 m and 7 m with average grade of 0.20%, 0.29%, 0.43%, 0.35%, 0.34% and 0.33% respectively.
	Mahawa North block	Drilling & Sampling	During G3 stage preliminary exploration, four scout borehole were drilled for a total depth of 501.0 m to check the sub-surface continuity of mineralised zone established on surface. Only 2 boreholes intersected any significant mineralisation that can be identified visually. Core samples sent for analysis.
	Northern part of Toda-Ramliyas block	Drilling & Sampling	During G3 stage preliminary exploration, a total of 1059.0 m was drilled in 7 boreholes to check the sub-surface continuity of mineralised zone established on surface. A total 300 nos. of core samples were sent for various types of analysis.
	Toda-Ramliyas block	Drilling & Sampling	During G2 stage general exploration, total 22 boreholes were drilled for a cumulative depth of 5882.10 m. Core samples were sent for chemical analysis and also for fluid inclusion studies, sulphur isotopes studies and EPMA studies.
Udaipur	Devimata-Pipaldaran area	Mapping & Sampling	G4 stage two year investigation programme was started in field session (FS) 2015-16. Detailed geological mapping of 1.60 sq km area was carried out in this block to delineate the copper zones with pitting/ trenching and collection of bedrock samples. The analytical result of bedrock samples collected from the old workings and nearby areas shows Cu values ranging from 550 ppm to 3.2%, Pb values 90 to 740 ppm and Zn values ranges between 150 ppm to 1.14%. Based on the old workings and anomalous Cu value in bedrock samples, two promising Cu mineralised zones have been delineated in the north of Devimata and near Pipaldaran. The mineralised zone of Devimata is approximately 700-900 m in length and 150 m in width, whereas mineralised zone of Pipaldaran is approximately 200 m long and 100 m wide. On the basis of detailed geological mapping (1:2000 scale) two mineralised zone MZ-I and MZ-II have been delineated in the Devimata block. MZ-I is more prominent mineraliszed zone. The anatylical results of Devimata block show Cu values ranging form 764 ppm to 0.79% Pb values from 288 ppm to 0.45% and Zn values from 140 ppm to 0.29%.

(Contd.)

Table - 4 (Concld.)

State/District	Name of block	Details of exploration	Results
Rajasthan			
Copper, Gold and Iron			
Udaipur	Padla-Chawand-Sarara area	Mapping & Sampling	G4 stage exploration (Reconnaisance survey) was taken up with the objective to assess the nature and potentiality of copper, gold and iron mineralisation in the area. LSM covering an area of 191 sq km has been completed. In order to know the possibility of mineralisation in the area, BRS, PT, Channel samples were sent for analysis. Results are awaited.
Sikkim			
Basemetal			
West & South Sikkim	Chakung-Chong Bong-Malthek-Naya Bazar area	Mapping & Sampling	During G4 stage reconnaissance survey, an area of 50.0 sq km was mapped in and around Chakung, Chongbong, Borbatey, Jugdum, Malbasey, Zoom, Khani Shirbung and Timberbong. Mineralisation was observed at Jugdam and Namrek. The analytical result reveals that in Namrek area, the copper content varies from 10 to 18 ppm from PTS samples. In Zoom area, Cu values ranges from 1.4 to 54 ppm in concentration. One rolled boulder in a nala section near Malbasey indicated 7.1% copper content and 218 ppm Pb content. The values for Co, Ni, Pb & Zn are not significant.
East Sikkim	Pachekhani-Pakyong-Mamring-Assam	Mapping & Sampling	During G4 stage reconnaissance survey, an area of 51 sq km was mapped in Pakyong, Linkey, Pachey, Pacheykhani, Pachekhola, Dugalakha, Rorathang and Dikling areas. Surface indications of mineralisation include malachite-azurite stains, gossans, limonitised rocks and occasional sulphide crystals and specks. In Pachekhani area Copper values range from 591 ppm to a maximum of 3,322 ppm with corresponding Zn value ranging from 517 to 613 ppm. Malachite/azurite stains are observed in mica schist/phyllitic rocks (Daling Group) at Pache-Linkey road section, Dikling-Lusing road sections and Terethang-Takshang areas.
	Rolep-Charapathang area	Mapping & Sampling	G4 stage reconnaissance survey was carried out. Large Scale Mapping has revealed the main rock types related to mineralised locations in the study area are amphibolites intrusion within quartzite of Chungthang Formation and Darjeeling Gneiss, phyllite interbanded with quartzite and chlorite-mica schist of Daling Group. Malachite stains were observed at few places along with specks of pyrite and chalcopyrite within the mica schist and phyllites. Chemical analysis for Bed Rock Samples (BRS) show copper concentrations of 5,012 ppm to 26,520 ppm in Suketar area and 8,937 ppm in Rorathang-Rongli road section. Samples from Lossep village show higher value of BRS results with 1,909 ppm of Cu, 393 &935 ppm of Pb, 39 ppm of Co and 173 ppm of Zn.
Tamil Nadu			
Sulphide (Basemetal) Dindigul & Karur	Vattalagundu-Idaiyakottai Lineament zone	Mapping & Sampling	Large scale geological mapping on 1:12500 scale has been carried out in parts of Dindigul and Karur districts and an area of 100 sq km was covered in and around Idaiyakottai. The chemical analytical results so far received has not indicated any significant base metal mineralization zones. However, the Cu values range between 0.10% and 0.52% for 19 samples collected from Devanayakkanur and also the following spotted values are observed a) 1.5 km N of Kannimarpalaiyam – 0.14% of Cu, b) 0.5 km SW of Pappanayakkanpatti – 4.86% of Cu.

BAUXITE

GSI

In Chhattisgarh, a G2 level general exploration for bauxite ore was carried out in Pakhritola north block, Jashpur district. Total 1,155.8 m was drilled in 77 boreholes, with approximate depth of 15 m of each boreholes. Maximum thickness of 4.25 m ore zone (bauxite/aluminous laterite/laterite with pockets of bauxite) is intersected. Bauxite is grey to purplish grey and occurs as discontinuous pockets, boulders and lenses within the laterite and aluminous laterite. Mainly two varieties of bauxite are present – massive and pisolitic. Al_2O_3 values of surface samples of bauxite yielded encouraging results with Al_2O_3 ranging from 50.82 to 57.70%. General thickness of ore zone intersected is between 0.5 m and 1.5 m. XRD results of four bauxite samples revealed that gibbsite is the dominant mineral phase along with minor boehmite, anatase and haematite.

A G2 stage general exploration for bauxite ore was carried out in Pakhritola south block, Jashpur district. Objective of exploration was to assess bauxite ore in this block. Detailed mapping was carried out on 1:2000 scale. An additional area of 0.15 sq km was mapped in detail. The drilled boreholes intersected soil, laterite, bauxite, aluminous laterite and lithomarge. Bauxite zone occurs in the form of thin to moderately thick, flat lenticular bodies. The ore zones (bauxite/ aluminous laterite/ laterite with pockets of bauxite) intersected are 1 m to 2.0 m thick, maximum being 5.1 m to 5.5 m. The boreholes in the eastern side of the block are more potential. PCS analysis of six samples revealed that the ores are mainly composed of Al_2O_3 (56.21 to 50.58 wt.%), SiO_2 (2.02 to 1.26 wt.%), Fe_2O_3 (6.53 to 3.82 wt.%), and TiO_2 (8.18-10.6 wt.%) with LOI ranging from 24.7 to 22.63 wt.%. XRD study reveals gibbsite as the major mineral phase along with minor content of bohemite, anatase, haematite, quartz and kaolinite. Bulk density of bauxite in this area is 1.912 tonnes/cu.m.

A G2 stage general exploration for bauxite ore was carried out in Dantalgawa block, Jashpur district. A total of 2 sq km area was mapped. The detailed map of Dantalgawa block shows laterite, laterite with pockets of bauxite, aluminous laterite with pockets of bauxite, pisolitic bauxite and massive bauxite. Aluminous laterite (float ore) has been noticed mostly in the eastern and centre part of the block. Exposures of massive and pisolitic bauxite are sporadic. Thickness of bauxite varies between 0.5 m and 2.0 m. Petrochemical samples, XRD samples and water samples were collected for analysis.

A G2 stage general exploration for bauxite ore was carried out in Datunpani block, Jashpur district. An area of 2 sq km was covered by detailed mapping on 1:4000 scale. Pockets of bauxite are also exposed on the surface mostly in the western part of the area in scarp section. Aluminous laterite (float ore) of two varieties has been observed; one with small pockets of bauxite and the second one which is devoid of bauxite. Occurrences of massive bauxite have been reported at a few locations. Massive bauxite is mainly composed of gibbsite, boehmite and anatase. Pisolitic bauxite and aluminious laterite contain goethite and hematite apart from gibb- site, boehmite and anatase as confirmed from XRD results.

A G2 stage general investigation was taken up for bauxite ore in Rajpur Block, Jashpur district. Total 2,160 m of drilling and detailed mapping of 2 sq km on 1:4000 scale were carried out. Extensive lateritisation of the Deccan traps has resulted in the development of irregular, isolated patches of laterite/ aluminous laterite with pockets of bauxite. They occur as caps over the plateaus and isolated hills. Laterite is mostly reddish to reddish brown, pisolitic and porous. In the western part of the area, below escarpment laterite contains pockets of bauxite. Pockets of bauxite are also exposed on the surface mostly in the western part of the area. Bauxite is cement grey, hard, compact, massive to pisolitic. Aluminous laterite (float ore) of two varieties had been observed; one with small pockets of bauxite and the other which is devoid of any bauxite. Pisolitic bauxite is found as patches at west of Rajpur block. Massive bauxite occurs as small patches of 100 m length, 10 m width & 2 m thickness in the north of Rajpur block on the outskirts of Kadampat village. In the southern part of the block, another outcrop of about 60 m length and 30 m width is exposed. Average thickness of bauxite is about 3 m. Even smaller patches of massive bauxite of comparatively smaller thickness can be noticed near the eastern boundary of the block.

A G3 stage preliminary exploration for bauxite ore was carried out in Ghardega – Kurkuria block, in Jashpur district. The area of 4.5 sq km was covered by detailed mapping on 1:5000 scale to demarcate occurrences of bauxite ore and associated aluminous laterite. The bauxite zone occurs in the form of pockets and lenses within the laterite and aluminous laterite. The bauxite is massive, hard, compact, pisolitic in nature and shows shades of light grey and pink colour. Pisolitic bauxite was observed at the elevated south-central part of the study area. Aluminous laterite (float ore) had been observed towards south of Kurkuria village. The ore is generally restricted in two horizons. The thickness of the bauxite zone varies from 0.15 m to 5.00 m. Bauxite horizons occur as irregular and discontinuous lenses, lensoids or tabular bodies within laterite. Discontinuous massive bauxite ore is observed having 500 m length, 5 m width & 2-3 m thickness, in the north western scarp section at 1 km west of Kurkuria village. Thickness of bauxite varies between 0.5 m and 3.0 m in this scarp section. Total 335.35 m was drilled in 26 numbers of boreholes, on 200 m X 400 m grid interval.

In Karnataka, a G4 stage reconnaissance survey for bauxite was taken up in Western Ghat belt in Kabri-Honnabar-Apsarkond areas,Uttar Kannada district. Large Scale geological mapping on 1:12500 scale had been carried out. The laterite profile composed of limonite, goethite, haematite, laterite and free silica in different proportions is found at all places. Lithomarge, at the bottommost part of lateritic profile is generally not very well developed. The total 65 sq km area is covered by laterite capped plateaus. The average thickness of the laterite profile is approximately 6.5 m. Based on the analytical chemical data values, Fe content varies from 1.428 to 48.27% and values of Fe_2O_3 content varies from 2.04 to 69.1%. Values of Al_2O_3 content varies from 10.52 to 56.17%. Value of SiO_2 content varies from 2.87 to 73.8%. Values of Al_2O_3 ranging from 39 to 56% have been reported from the bedrock sample analysis in the Navilgaon and Haldipur plateau. The XRD results of bauxite samples show Gibbsite in major amount, Kaolinite in minor amount and quartz in trace amount.

In Gujarat, a G4 reconnaissance survey for lateritic bauxite and lithomargic clay was taken up around Umarsar area, Guneri area and Western Kachchh. Detailed mapping of an area of 5 sq km on 1:5000 scale and grid sampling were carried out including Geochemical, XRD and petrographic samples. Eastern part of the laterite-bauxite belt is lateritic, central part is pisolitic and western part being clayey bauxite. The thickness of laterite varies from 1- 2 m whereas thickness of bauxite varies from 50 cm to 10 m and that of lithomargic clay from 30 cm to 5 m. Chemical analysis of six sample has been received and out of these three samples are having more than 35% of Al_2O_3.

In Jharkhand, a G-3 stage preliminary exploration for bauxite and associated minerals (Ti, V, Ga etc.) was carried out in Risahattoli block, Serangdag Plateau, in Gumla district. A total of 5.2 sq km area was mapped on 1:4000 scale. A total of 485 m was drilled in 12 boreholes. Thickness of the bauxite zone intersected in the boreholes varies from 3.2 m to 14.75 m with an average thickness of 9.78 m. The bauxite zone is found to reach up to a maximum depth of 27.09 m. Alumina (Al_2O_3) content ranges from 43.04% to 47.60% with SiO_2 varying from 4.74 to 9.26%. The main ore mineral is gibbsite with anatase and goethite. Content of TiO_2 in bauxite zones varies from 10.18 to 11.09 %, Vanadium (V) from 594 to 704 ppm and Gallium (Ga) from 38 to 62 ppm.

FERROUS MINERALS

CHROMITE

GSI

In Bihar, a G4 stage reconnoissance survey for Cr, Ni & PGE Group of Elements was carried out within Mafic-Ultramafic Suite of rocks in Masuribaad-Pipargarhi-Ahirtola-Genjana sector of Aurangabad and Gaya districts. Large scale mapping on 1:12500 scale was carried out in these blocks. Trench samples of metapyroxenite have yielded PGE values of 766 ppb, 347 ppb, 272 ppb, 51 ppb and 6 ppb with an average value of 288 ppb having anomalous enrichments of Pt+Pd and also Cr content of 1,619 to 3,119 ppm and Ni content of 629 to 1,518 ppm. PGE mineralisation has been established over a strike length of 1 km.

In Jharkhand, a G4 stage reconnoissance survey for Cr, Ni & PGE was taken up in Ranjrakochajanoa-Jojohatu-Tonto area, West Singhbhum district. The

chromite mineralisation occurs as pods and disseminated grains within dunite and harzburgite in the Jojohatu and Tonto Blocks. In the Ranjrakocha block, the mineralisation is in the form of disseminated grains. The chromite mineralisation in the Janoa block also occurs as disseminated grains in the ultramafic rocks and also within the metabasic rocks as large grains. PGE mineralisation is mainly associated with the ultramafics. PGE concentration shows a maximum value of 0.8 ppm while the highest value of chromite is 38 wt.% and the value of Ni is 5.14 wt %.

In Nagaland, a G4 stage investigation for Chromium, Nickel, Copper and associated basemetal was taken up in Naga Hills Ophiolite, Phek district. A total of 50 sq km area on 1:12500 scale was covered in parts of Ophiolite belt in Phek district in and around Reguri-Ankhen villages. Chromite specks /grains and a small pod have been recorded from the cumulate boulders in the central part of Reguri village. Occasional minute chromespinels have been noted in cumulates.

In Tuensang district, a G4 stage search for Chromium and associated base metal was taken up in Naga Hill Ophiolite. Large Scale Mapping on 1:12500 scale was carried for 75 sq.km area in and around Wui and Khenjong village. Limonitised /ferruginised zone with a strike length of 40 m and width of 10 m is exposed towards the SE of Wui village.

IRON ORE

GSI

In Assam, a G3 stage preliminary exploration was carried out for low grade iron ore in Chandradinga area, Goalpara district. Banded Iron Formation (BIF) in Chandardinga area is primarily banded magnetite quartzite and banded haematite quartzite which occur as scree/talus boulders along with few outcrops. Amphibolite forms the basement rock for iron ore. Fe(T) in iron ore varies from 48.26% to 63.01% as seen from analysis of 11 petrochemical samples. In Chandardinga block, drilling of 500 m in 200 m X 200 m grid pattern has been completed in nine boreholes The thickness of ore zone encounters in different boreholes varies from 9.5 m to 96 m. In some boreholes a sulphide rich zone has also been recorded below iron ore. A total of 300 samples from the iron ore zone have been submitted for analysis. Results are awaited.

A G4 stage search was carried out for Iron ore in Kumri area (Paglatek-Khutamari hills), Goalpara district. An area of 50 sq km has been mapped on 1:12500 scale and 1.5 sq km covered by detailed mapping on 1:2000 scale in Kumri area. The mapped area is occupied by the Precambrian basement gneissic complex and Quaternary alluvial sediments of Brahmaputra Valley. The Precambrian basement gneissic complexes are exposed in the isolated hillocks and comprises of calc granulite, banded magnetite quartzite (BMQ), amphibolites, muscovite quartz schist, granite gneiss, granite, pegmatite and quartz veins. Banded magnetite quartzite has been observed at Khutamari hill which has strike length of about 750 m-800 m and 220 m-260 m in width. Out of 28 BRS samples collected, the analytical data for 20 BRS samples have been received which show FeO(T) from 47.29 to 64.48%. Total 26 pit & trench soil samples were collected from the 8 trenches of iron ore bearing area shows FeO(T) maximum value of 21.56% and minimum value of 7.53%.

In Bihar, a G4 stage reconnoissance survey was taken up in search of magnetite - ilmenite mineralisation in Gaya - Bela area, Gaya and Jehanabad districts. Five major magnetite bodies have been delineated, viz. (i) NE of Sudama Kund (800 m x 200 m) (ii) NW of Patal Ganga (500 m x 100 m), (iii)NW of Nagarjuni hills (500 m x 100 m) (iv) 750 m SW of Patal ganga near Ramnath Bigha, and (v) East of Phalgu river (200 m x 40 m). Total Fe contents of these different ore bodies varies from 41.30 to 60.58% and that of TiO_2 from 2.55 to 26.77% and concentration of SiO_2 and P_2O_5 varies from 0.5 to 8.74% and 0.01 to 0.05% respectively. The magnetite ore body found to the east of Phalgu river shows the highest value (60.58%) of total Fe and the magnetite ore body to the NE of Sudama kund shows the highest value (26.77%) of TiO_2.

In Jamui district, a G3 stage preliminary exploration was carried out in search of magnetite around Majos. Detailed mapping of 2.1 sq km area around village Majos has been carried out on 1:2000 scale. Out of a total 152 bedrock samples, 41 show > 45% Fe content with a maximum of 56.08%. Fifteen core samples and eighteen trench samples both show > 40% Fe content.

In Karnataka, a G3 stage preliminary exploration for iron ore resource was carried out in notified Block 4B/C116/MMM 2003 of Kumaraswamy Hill Range, Ballari district. An impersistent iron ore band of average width 34 m and cumulative length of 1,180 m had been delineated on 1:2000 scale. The total surface area of the ore body is 0.04 sq km with mineralisation factor 0.027. The iron ore band mostly consists of haematite, goethite, with minor amount of ferruginous clay, limonite and specularite. The average (of 18 samples) Fe% in the band is 44.79%.

In Ballari district, a G-3 stage investigation was taken up in blocks 13/1(north) and 6B/C116 MMM 2003 of Ramandurga Hill range with an objective to establish the grade of the iron ore bodies and assess the resources in the area along with detailed mapping on scale of 1:2000. BIF bands are associated with shale. The shale is ferruginous at places, the concentration of haematite is more forming pocket deposit. The banded iron formation is the most important litho unit of the study area because it is the proto-ore for the high grade iron ore deposits. The surfacial width of individual bands varies between 5 m and 160 m. On request from DGM, Govt. of Karnataka, a G-3 stage investigation for iron ore resource in blocks 13/1(south) and 6A/C116 MMM 2003 of Ramandurga Hill range Ballari district was carried out with an objective to establish the grade of the iron ore bodies and assess the resource in the area. A single band of iron ore body with strike length of 1,500 m and true thickness of 170 m-180 m is targeted for exploration. Total 121 samples collected from mineralised zone shows Fe content varying from 13.65 to 66.07% with an average of 51.41% Fe. Analytical results of 95 samples out of 121 have given Fe values above cut off grade i.e. 45% in Tumakuru and Chitradurga districts.

A G3 stage preliminary investigation for iron ore in Kenkere block in Hosadurga taluka, Chitradurga district and Chikkanyakahalli taluka, Tumakuru district were carried out by detailed mapping of total 2 sq km area on 1:2000 scale. The litho units exposed in the area are dolomitic limestone, Mn phyllite, argillite and banded haematite quartzite. Exploration will continue.

In parts of Haveri and Shivamogga districts, a G-4 stage reconnaissance survey was taken up for Banded Iron formation (BIF). A total of 100 sq km area was mapped on Large Scale Mapping along with collection of samples covering the iron ore formations located in parts of Shikaripura taluka, Shivamogga district. A cumulative strike length of 31,825 m of BIF band was delineated**.** Four potential BIF bands were identified based on iron oxide content. Based on the results received so far, BIF bands IX, XI and XII are of low to medium grade iron ore.

In Madhya Pradesh, a G3 level preliminary investigation for iron ore was carried out in Morar sub Group of Gwalior Group of rocks in Motijhil-Akbarpur and surrounding areas in parts of Gwalior district**.** Detailed mapping of 1.5 sq km area on 1:2000 scale and large scale mapping of 10 sq km on 1:12500 scale was carried out. About 1 km strike length with 600 m width of iron ore mineralisation was delineated on the basis of detailed geological mapping and sampling. In Motijhil block, the delineated iron ore mineralisation was of 800 m strike length & 400 m width. Total drilling of 445.20 m has been completed. Ore zones were identified with cut off grade of 30% based on the visual estimation and partial analytical results of core samples.

In Jabalpur district, a G4 stage investigation for iron ore was taken up in Sihora – Gosalpur area. An area of 100 sq km was mapped on 1:12500 scale alongwith detailed mapping of 0.5 sq km area on 1:5000 scale. Total 150 bedrock samples (BRS), 5 petro chemical samples (PCS) and 50 pit trench samples (PTS) through 50 cu m trenching were collected to identify the possible existence of the iron ore. Analytical results received so far show average iron content ranging from 40-42%. Five BRS samples of suspected manganese mineralisation collected from brecciated zone (located near Tola village) show manganese values between 28.44 and 59.62%.

A G4 stage reconnaissance survey was taken up for Iron ore in Mahakoshal Belt, Jabalpur, Katni, Rewa, Sidhi, Shahdol and Singrauli districts. In some areas viz. Sleemnabad, Jhinna Pipariya, Kuan and Rajarwara, LSM and detailed mapping was recommended to trace the BIF, manganese occurrences and bauxite deposits in selective areas for delineating primary and secondary enrichment beneath the lateritic cap zone.

In Tikamgarh district, during G4 stage reconnaissance survey for iron ore in Dhaurra-Urdaurra area, large scale mapping of 20 sq km on 1:12500 scale and detailed mapping of 1.5 sq km on 1:4000 scale and

a total of 207 m drilling in two scout boreholes in Dhaukan block was carried out to study the subsurface extension of iron ore mineralisation. There are 3 major bands of BIF occurring as enclaves within gneisses near Dhaukan-Dhaurra-Urdaurra villages. The true thickness of mineralised zones varies from 65.22 m to 38.79 m and Fe content varies between 40 and 57% in the analysed core samples.

In Odisha, a G2 stage general exploration for iron ore was carried out in Rengalaberha North East Block, Kendujhar district. Drilling of 2071.15 m was completed in 22 boreholes at 1000 m x 100 m grid interval. An area of 0.30 sq km was mapped on 1:2000 scale. Within the freehold area, iron ore body is exposed in this block for a maximum strike length of 350 m. Across the strike the ore body is exposed on the surface for around 700 m and can be traced further towards north. The rock types exposed in the area are mainly hard laminated ore (HLO), fragmented laterised ore, lateritic ore and ferruginous laterite. All the boreholes except boreholes no. 4 have intersected considerable thickness of ore zones. The cumulative thickness of ore zones intersected in boreholes varies from 25.60 m to 125 m. On the basis of analytical results, a total resources of 23.87 million tonnes of high grade ore (cut off 55% Fe) with average Fe content of 61.88% has been estimated. In addition to this, low grade (45% to 55%) resources of 5.0 million tonnes with average 50.04% Fe has been estimated.

In Kendujhar district, a G3 stage preliminary exploration for iron ore was carried out in Gandhalpada South-East, Part-B. Detailed geological mapping over an area of 0.83 sq km on 1:2000 scale was carried out in the block. 12 boreholes were drilled at 200 m x 200 m grid interval. All the boreholes intersected ore zones (including low grade) with thickness varying from 12.00 m to 122.80 m as per the visual estimation. The study will continue in field session 2017-18.

A G2 stage General exploration for iron ore was carried out in Gandhalpada South-East, Part-A, Kendujhar district. A total of 29 boreholes for a cumulative depth of 2689.30 m have been drilled in 200 m x 100 m grid pattern. On the basis of analytical results, a total resources of 51.11 million tonnes high grade ore (cut off 55% Fe) with average Fe content of 61.13% have been estimated. Besides, low grade (45-55% Fe) resources of 9.44 million tonnes with average 49.64% Fe have also been estimated.

In Sundargarh district, a G3 stage preliminary exploration for iron ore was carried out in Jhumka Pathiriposhi west block. An area of 1.28 sq km was mapped on 1:4000 scale. The litho units observed in the area are soft laminated iron ore, BHJ/BHQ and laterite. A total of 492.95 m was drilled during 2016-17. Eight bore holes have been completed in 200 m x 200 m grid & two boreholes are under progress. All the boreholes are vertical with depth varying from 37.60 m to 64.30 m. In boreholes, cumulative thickness of low grade and high grade ores varies from 6.7 m to 54.65 m. Ferruginous laterite, brownish powdery iron ore, soft laminated iron ore & ferruginous shale are the main litho units encountered in boreholes. The exploration will continue in 2017-18.

In Tamil Nadu, a G4 stage reconnaissance survey for iron ore was taken up in the BMQ between Namagiripettai and Tammampatti, Namakkal and Salem districts. Geological mapping of an area of 100 sq km on 1:12500 scale was carried out. A total of 406 nos. of BRS samples was collected from major BMQ bands for iron ore analysis and 10 limonitised/oxidized samples for gold analysis. In Pachchudaiyanpalaiyam block, 3 major BMQ bands were delineated. Band I has a cumulative strike length of 4.65 km with an average outcrop width of 8 m. The Fe ranges from 10.40 to 43.74% (avg. 31.73% Fe). Band II has a cumulative strike length of 4.25 km with an average outcrop width of 6 m. The Fe ranges from 15.72 to 40.29% (avg. 29.77% Fe). Band III has a strike length of 1.7 km with an average outcrop width of 6.4 m. and Fe ranges from 21.77 to 33.06% (avg. 28.77% Fe). Band IV is a minor band. In Kariampatti block, 4 major BMQ bands were demarcated. Band I has a cumulative strike length of 1.1 km with an average outcrop width of 0.95 m. The Fe ranges from 19.58 to 20.17% (avg. 19.87% Fe). Band II extends up to a strike length of 3 km with an average outcrop width of 1.8 m and the Fe value ranges from 7.16 to 35.22% (avg. 15.15% Fe). Band III has a strike length of 3.7 km with an average outcrop width of about 2.5 m. The Fe ranges from 8.33 m to 33.24% (avg. 19.81% Fe) and band IV has the longest cumulative strike length of 7.17 km with an average outcrop width of 5.9 m. The Fe value ranges from 5.11 to 39.12% (avg. 22.96% Fe). Some (Nine) minor bands were also reported in this block. In the Ulipuram block, two major BMQ bands were delineated. Band I has a cumulative strike length

of 3.1 km with an average outcrop width of 7.8 m. The Fe ranges from 13.81 to 37.57% (avg. 21.99% Fe). Band II has a strike length of 1.55 km with an average outcrop width of 8.25 m. The Fe ranges from 12.41 to 38.99% (avg. 27.96% Fe). Two minor bands are admeasuring 1 km and 0.25 km in strike length were also identified. Ore reserves/resources were estimated for all the 3 blocks. Two cut off grades were considered for resource estimation i.e. 10-25% Fe & 25 – 40% Fe. The total iron ore reserves/resources of both grades in Pachchudaiyanpalaiyam block are 7.391 million tonnes; in Kariyampatti block, it is 7.296 million tonnes and in Ulipuram block, it is 4.779 million tonnes. Hence, total resources of low grade iron ore in the area are 19.466 million tonnes with average of 26.25% Fe content over an average width of 6.36 m.

In Telangana, a G2 stage general exploration was carried out for assessment of iron ore resources in Yerraballi block in Karimnagar district. Out of total 11 BMQ bands, only four bands viz. band nos. 2,3,8 & 10 were selected for detailed mapping on 1:2000 scale covering an area of 4.0 sq km. Total 160 BRS and 100 trench samples were collected from above 4 bands in which total Fe content vary from 10.7% to 61.69% with an average of 37.25%. The investigation is in progress.

A G3 stage preliminary exploration was carried out for assessment of iron ore resources in Arnakonda in Karimnagar district, Chandoli Ambaripeta blocks in Jagtiyal district and Rebbanapalli block in Mancherial district. Large Scale Mapping of 30.8 sq km area in 3 blocks led to identification of Chandoli-Ambaripeta and Rebbanapalli block as most promising area for iron ore. Total 5 sub blocks (2 blocks in Chandoli-Ambaripeta block and 3 sub blocks in Rebbanapalli block) of cumulative 3.98 sq km area was mapped on 1:2000 Scale. Iron ore mineralisation in the area is present in the form of BMQ band. Cumulative strike length of mineralised BMQ band in Rebbanapalli block is 4 km with average width is 60-80 m. Chandoli east block is having width of BMQ band 100 m with 600 m strike length, while in Chandoli west block length of BMQ band is 1.3 km and average width is 60-80 m. Eight boreholes proposed in 5 sub block to ascertain the depth persistence of the entire BMQ band, their grade and thickness at depth.

A G4 stage preliminary exploration was taken up for assessment of iron ore resource in Sitanagaram Macheria Block Khammam schist belt, Warangal district and in Lacchpuram block, Pakhal Basin, Khammam district. In Sitanagaram-Macherla and Lacchpuram blocks, a total 70 sq km area was mapped by Large Scale Mapping on 1:12500 scale and bed rock sampling was also carried out. Detailed mapping of 3.0 sq km area on 1:2000 scale was carried out in Sitanagaram block. BMQ band with a cumulative strike length of 2.6 km having average width of 20 m and average grade of 32.5% Fe is demarcated in the Detailed Mapping block. However, drilling could not be taken up as entire potential area was falling within the Pakhal wild life sanctuary. Iron ore reserves/resources have been estimated at 1.202 million tonnes up to a depth of 10 m with an average grade of 33.127% (Total Fe).

A G3 stage preliminary exploration for assessment of iron ore resources in notified blocks; Gurimalla, Dabripet, Abbapur, Mallampalli in Khammam and Warangal districts were carried out. After LSM in all the 3 blocks, only Gurimalla-Yerragunta block was identified for detailed mapping on 1:2000 scale. This block is sub divided into 3 sub blocks of cumulative 3.12 sq km area. Iron ore mineralisation in BIF bands has a strike length of 1 km – 1.2 km with average width of 20 m – 40 m and average Fe content of about 35 – 40%. Three boreholes were drilled in Yerragunta sub block for a total meterage of 246.8m. The estimated resources (25% Fe) of BIF band in Yerragunta sub block are 1.03 million tonnes (cross section method) and 0.97 million tonnes (LV section method) under inferred category. The investigation is in progress.

MECL

MECL carried out exploration with a main objective of determination of i) the strike and depth continuity of iron ore in the mining lease area, ii)Lump & fines ratio, iii) mineralised/non-mineralised area, iv) associated minerals and quantification of resources as per threshold value, etc. in various leasehold areas. The details of exploration for iron ore carried out by MECL during 2016-17 are given in Table -5.

Table - 5:Exploration for iron ore by MECL, 2016-17

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (Hects)	Boreholes	Meterage		
Chhatisgarh							
Balod	Jharandalli Mechanized Mine (phase V)	-	-	18	1443.4	951	Exploratory drilling for mine suport has been carried out by MECL for SAIL.
	Rajhara Mechanised Mine,Dalli-Rajhara, ML No. 2148	-	-	5	1360.00	506	Exploratory drilling for mine support has been carried out by MECL for SAIL.
	Dalli Mechanised Mine (Phase V), Dalli-Rajhara	-	-	27	2678.50	1697	Exploratory drilling for mine support has been carried out by MECL for SAIL.
Karnataka							
Ballari	M/s S.B. Minerals Ltd, ML No. 2550	1:1000	0.394	24	1050.5	972	Exploration was carried out with an objective of determination of i) lump & fines ratio ii) mineralised/non-mineralised area iii) associated minerals and quantification of resources as per threshold value, etc. a) About 4.203 million tonnes of iron ore reserve have been estimated with average grade of Fe 57.28%, 10.18%, SiO_2 5.42%, Al_2O_3 at 45% Fe cut off. b) About 3.630 million tonnes of net reserve have been estimated with average grade of Fe 60.36%, SiO_2 6.82%, Al_2O_3 4.48% at Fe 55% cut off under (121) category.
	M/s Trident Minerals Ltd, ML No. 2315	1:1000	0.3243	19	856.1	789	Exploration was carried out with an objective of determination of i) Lump & fines ratio, ii) mineralised/non-mineralised area, iii) associated minerals and quantification of resources as per threshold value, etc. a) About 2.153 million tonnes reserve have been estimated with average grade of Fe 54.37%, SiO_2 19.02%, Al_2O_3 3.02%, Fe 45% cut off. b) About 1.323 million tonnes with average grade of Fe 59.57, SiO_2 11.10%, Al_2O_3 2.89% at Fe 55% cut off under (121) category.
	Kanhaiyalal Dudheria ML No. 2563 Ramandurga village	1:1000	0.3009	19	1278.3	1191	Exploration was carried out with an objective of determination of i) Lump & fines ratio, ii) mineralised/

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Table - 5 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (Hects)	Boreholes	Meterage		
							non-mineralised area, iii) associated minerals and quantification of resources as per threshold value, etc. Reserves/Resources.About 9.26 million tonnes reserves have been estimated with average grade of Fe 50.89%, SiO_2 17.9%, Al_2O_3 4.56% at Fe 45% cut off, b) About 4.588 million tonnes reserves have been estimated with average grade of Fe 59.34%, SiO_2 8.85%, Al_2O_3 4.36% at Fe 55% cut off under (121) category.
	Smt.Santhalakshmi Jayaram ML No. 2553 Kallahalli village	1:1000	0.3253	20	1119.8 1063		Exploration was carried out with an objective of determination of i) Lump & fines ratio, ii) mineralised/ non-mineralised area, iii) associated minerals and quantification of resources as per threshold value, etc. Reserves/Resources. a) About 4.542 million tonnes reserves have been estimated with average grade of Fe 49.52%, SiO_2 23.97%, Al_2O_3 2.87% at Fe 45% cut off, b) 1.141 million tonnes reserves have been estimated with average grade of Fe 59.26%, SiO_2 4.30%, Al_2O_3 2.44% at Fe 55% cut off under (121) category.
	M/s.H.Rangana Goud, ML No. 2148 Ramgad Range	1:1000	0.6066	48	3280.7 3071		Exploration was carried out with an objective of determination of i) Lump & fines ratio, ii) mineralised/ non-mineralised area, iii) associated minerals and quantification of resources as per threshold value, etc. Reserves/Resources. a) About 63.331 million tonnes reserves have been estimated with average grade of Fe 58.84%, SiO_2 6.54%, Al_2O_3 4.25%, b) 48.102 million tonnes reserves have been estimated with average grade of Fe 62.75%, SiO_2 3.40%, Al_2O_3 3.25% at Fe 55% cut off under (121) category.

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Table - 5(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (Hects)	Boreholes	Meterage		
	M/s.Bharat Mines & Minerals Ltd, ML No. 2245, Kumaraswamy Range	1:1000	0.2447	19	880.80	1338	Exploration was carried out with an objective of determination of i) Lump & fines ratio, ii)mineralised/nonmineralised area, iii) associated minerals and quantification of resources as per threshold value, etc. Reserves/resources. a) About 7.577 million tonnes reserves have been estimated with average grade of Fe 52.19%, SiO_2 9.74%, Al_2O_3 6.85%, b) About 2.917 million tonnes reserves have been estimated with average grade of Fe 59.18%, SiO_2 4.65%, Al_2O_3 4.65% at Fe 55% cut off under (121) category.
	M/s.Mysore Minerals Ltd, ML No. 995 Donimalai Range	1:1000	0.3289	23	1253.7	1977	Exploration was carried out with an objective of determination of i) the strike and depth continuity of iron ore in the mining lease area, ii) Lump & fines ratio, iii)mineralised/non-mineralised area, iv) associated minerals and quantification of resources as per threshold value, etc. Reserves/resources. a) About 9.708 million tonnes reserves have been estimated with average grade of Fe 55.96%, SiO_2 13.39% and Al_2O_3 3.20% at Fe 45% cut off, b) About 8.407 million tonnes reserves have been estimated with average grade of Fe 60.96%, SiO_2 6.82% and Al_2O_3 3.44% at Fe 55% cut off under (121) category.

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Table - 5 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (Hects)	Boreholes	Meterage		
	Sri N. Manzoor Ahmed, ML No.1324/2616, North of Venkatagiri village	1:1000	0.1571	16	883.50	434	Exploration was carried out with an objective of determination of i) the strike and depth continuity of iron ore in the mining lease area, ii) Lump & fines ratio, iii) mineralised/non-mineralised area, iv) associated minerals and quantification of resources as per threshold value, etc. No mineralised zone could be demarcated within the area at threshold value cut off (45% Fe). Hence, resources were not estimated.
	M/s.Veeyam Pvt Ltd, ML No. 2615, Vadrahalli village	1:1000	0.2004	-	-	-	Exploration was carried out with an objective of determination of i) the strike and depth continuity of iron ore in the mining lease area, ii) Lump & fines ratio, iii) mineralised/non-mineralised area, iv) associated minerals and quantification of resources as per threshold value, etc. Reserves/Resources were not estimated.
	M/s S.B. Minerals Ltd, ML No. 2515 Vysankari village	1:1000	0.7125	6	539.00	582	Exploration was carried out with an objective of determination of i) the strike and depth continuity of iron ore in the mining lease area, ii) Lump & fines ratio, iii) mineralised/non-mineralised area, iv) associated minerals and quantification of resources as per threshold value, etc. Reserves/resources. About 0.896 million tonnes reserves have been estimated with average grade of Fe 52.84%, SiO_2 19.55% and Al_2O_3 3.57% at Fe 45% cut off under measured (331) and indicated (332) categories.
	M/s Rajapur ML No. 2190	1:1000	0.9175	3	226.00	257	Exploration was carried out with an objective of determination of i) the strike and depth continuity of iron ore in the mining lease area, ii)Lump & fines ratio, iii) mineralised/non-mineralised area, iv) associated minerals and quantification of resources as per threshold value, etc. About 0.088 million tonnes reserves/resources have been estimated with average grade of Fe 36.01%, SiO_2 38.48% and Al_2O_3 1.41% at Fe 35% planning cut off grade under measured (331) and indicated (332) categories.

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Table - 5 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (Hects)	Boreholes	Meterage		
Chitradurga	Sri Allum Veerabhadrappa ML No. 2436 Kenchihalli village, Hosadurga taluka	1:1000	0.2453	27	1330.00	5919	Exploration was carried out with an objective of determination of i) the strike and depth continuity of iron ore in the mining lease area, ii) Lump & fines ratio, iii) mineralised/ non-mineralised area, iv) associated minerals and quantification of resources as per threshold value, etc. Reserves/resources of a) about 3.645 million tonnes have been estimated with average grade of Fe 37.19%, SiO_2 19.42% and Al_2O_3 1.91% at Fe 35% cut off value under Measured (331) and Indicated (332) categories, b) 0.931 million tonnes of manganese resources with average grade of Mn 12.71% and Fe 27.39% at Mn 10% cut off value.
	M/s Thangavelu and others ML No. 2585, Doddabyaladakere village Hosadurga taluka	1:1000	0.6092	42	2101.90	6762	Exploration was carried out with an objective of determination of i) the strike and depth continuity of iron ore in the mining lease area, ii) Lump & fines ratio, iii) mineralised/ non-mineralised area, iv) associated minerals and quantification of resources as per threshold value, etc. Resources have been estimated of i) Iron ore at 3.303 million tonnes with average grade of Fe 46.43%, SiO_2 30.33% and Al_2O_3 1.67% at Fe 45% cut off value under measured (331) and indicated (332) categories, ii) Limestone at 5.650 million tonnes with average grade of CaO 37.35%, MgO 5.45% and SiO_2 13.05% at CaO 35% cut off value., iii) Dolomite at 8.994 million tonnes with average grade of MgO 15.18% and CaO 28.71%, at CaO 15% cut off value, iv) Manganese ore at 4.803 million tonnes with average grade of Mn 15.43%.

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Table - 5(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (Hects)	Boreholes	Meterage		
Tumakuru	M/s Karnataka Limpo Cement Industry, ML No.2650, Honnebagi & Bullenahalli village	1:1000	0.0647	8	361.00	472	Exploration was carried out with an objective of determination of i) the strike and depth continuity of iron ore in the mining lease area, ii) Lump & fines ratio, iii) mineralised/ non-mineralised area, iv) associated minerals and quantification of resources as per threshold value, etc. Reserves/Resources of about 0.598 million tonnes have been estimated with average grade of Fe 54.28%, SiO_2 11.95% and Al_2O_3 4.76% at Fe 45% cut off value under UNFC measured (331) and indicated (332) categories.
	M/s Deepchand Kishanlal, ML No.2348, Chickanayanakahalli and Tiptur taluka	1:1000	1.2492	47	2528.00	6471	Exploration was carried out with an objective of determination of i) the strike and depth continuity of iron ore in the mining lease area, ii) Lump & fines ratio, iii) mineralised/ non-mineralised area, iv) associated minerals and quantification of resources as per threshold value, etc. Reserves/resources of a) about 34.939 million tonnes have been estimated with average grade of Fe 53.46%, SiO_2 8.41% and Al_2O_3 8.68% at Fe 45% cut off value. b) about 18.168 million tonnes reserves have been estimated with average grade of Fe 56.66%, SiO_2 6.15% and Al_2O_3 7.15% at Fe 55% cut off value under UNFC code (121) category.

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Table - 5 (Concld.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (Hects)	Boreholes	Meterage		
	M/s Mysore Stoneware & Potteries Ltd., ML No.2521, Somanahalli & Sondenahalli villages, Chikkanayakanahalli and Tiptur taluka	1:1000	1.2265	22	1512.00	3002	Exploration was carried out with an objective of determination of i) the strike and depth continuity of iron ore in the mining lease area, ii) Lump & fines ratio, iii) mineralised/non-mineralised area, iv) associated minerals and quantification of resources as per threshold value,etc. Reserves/Resources of a) about 12.945 million tonnes have been estimated with average grade of Fe 54.04%, SiO_2 9.24% and Al_2O_3 7.96% at Fe 45% cut off value, b) 8.782 million tonnes reserves have been estimated with average grade of Fe 56.47%, SiO_2 7.15% and Al_2O_3 6.79% at Fe 55% cut off value under UNFC code (121) category.
Tumkuru	Sri B.R. Surendranath Singh, ML No.2187, Honnebagi & Bullenahalli villages	1:1000	0.2371	20	584.40	657	Exploration was carried out with an objective of determination of i) the strike and depth continuity of iron ore in the mining lease area, ii) Lump & fines ratio, iii) mineralised/non-mineralised area, iv) associated minerals and quantification of resources as per threshold value, etc. About 0.869 million tonnes reserves/ resources have been estimated with average grade of Fe 46.92%, SiO_2 11.63% and Al_2O_3 9.72% at Fe 45% cut off value under UNFC code (331) / (332) categories.
	M/s Sri G. Rajashekhar ML No.2229, Mavinahalli village Gubbi taluka	1:1000	1.2742	24	1697.00	6714	Exploration was carried out with an objective of determination of i) the strike and depth continuity of iron ore in the mining lease area, ii) Lump & fines ratio, iii) mineralised/non-mineralised area, iv) associated minerals and quantification of resources as per threshold value, etc. About 1.765 million tonnes reserves/ resources have been estimated with average grade of Fe 49.02%, SiO_2 7.95%, Al_2O_3 2.10% and Mn 3.70% at Fe 45% cut off value under UNFC code (331) / (332) categories.

NMDC

During 2016-17, NMDC carried out exploration in DIOM - BMMX, 2W, 3E & SB deposits, Donimalai village, Ballari district, Karnataka to know the depth persistence and lateral extension of the ore body. Total 34 boreholes were drilled to a cumulative depth of 1926.00 m and collected 1040 samples. Total resources were estimated at 43.01 million tonnes i.e. 38.91 million tonnes under UNFC code (111) and 4.19 million tonnes under UNFC code (211).

MANGANESE ORE

GSI

In Jharkhand, a G4 level reconnaissance survey was taken up for manganese, phosphate and barium mineralisation in North Singhbhum Mobile Belt (NSMB) around Niponitola-Chamta – Bangora area, Saraikela – Kharsawan district (MoM block). The area is a part of arcuate shaped NSMB. Large scale mapping of 100 sq km area on 1:12500 scale was carried out along with PT, BRS, etc. Three manganese bands have been delineated within the interlayered sequence of acid volcanic/tuff and quartzitic rocks, having strike lengths of 1150 m, 2300 m and 600 m and exposure widths of 25 m, 30 m-60 m and 4 m.

In Karnataka, G4 level reconnaissance survey was taken up for manganese protore in Doddaguni basin, Tumakuru district. The investigation for manganese was proposed by the DMG, Govt. of Karnataka. Evidences for multiple phases of deformations are observed at many places in the area. The manganese concentration is found in the fractured zones at the hinges of folds. The main protore forming manganese minerals are psilomelane and pyrolusite occurring as irregular pockets and lenses and are confined to the banded iron–manganese chert. The analytical results are awaited. However, based on available bed rock and trench samples results, Mn values range from 0.78% to 27.4% and Fe values from 7.54% to 45.78%.

In Madhya Pradesh, a G2 level general exploration was carried out for manganese mineralisation in western block of Ukwa, Balaghat district. In Western Ukwa block, a total of 1071.35 m of drilling was done with 6 boreholes for second and third level to know strike and depth continuity of manganese horizon. A total of 10.015 m thick manganese ore horizon was intersected in 6 different boreholes with thickness of ore horizon varies from 0.15 m to 3.61 m.

In Odisha, a G3 level preliminary exploration was carried out for manganese in Gudighat Barbandha area, western part of Eastern Ghats Granulite Belt, Bolangir district by detailed mapping on 1:1000 scale over 2.0 sq km area along with pitting, trenching and bedrock sampling**.** The ore is exposed as isolated mounds around Babejuri village and can be traced discontinuously for about 750 m strike length, with an average width of 10 m. The southern-eastern band being the most significant and promising has a strike length of 700 m with an exposed width varying from 5 to 40 m. Another manganiferous band was delineated in Balikhamar area for 240 m strike length with an average width of 10 m. Chemical analysis of 50 trench samples and 50 bedrock samples indicates manganese values ranging from 3.05 to 24.40% in trench samples and from 4.22 to 26.61% in BRS. Out of 9 boreholes drilled, 8 boreholes intersected manganiferous ore zone. Analytical results of 60 core samples indicate Mn values ranging from 1.98% to 18.98%. Only 26 samples assayed >10% Mn.

A G4 level reconnaissance study for Manganese ore was taken up in Boringpadar – Amath Block, Eastern Ghats Granulite Belt, Kalahandi district. A total of 100 sq km areas were mapped on1:12500 scale along with collection of BRS/SS, PTS, etc. Two bands of manganese ore have been observed at the contact of calc-silicate granulite and khondalite. First band is mapped towards south-east of Boringpadar. The manganese minerals are mostly pyrolusite and psilomelane showing botryoidal form. The ore body extends for a strike length of 200 m with a width of 50 m. A second band of manganese ore has been mapped towards north-east of Amath for a strike length of 250 m and width of 40 m. The ore body is mostly brecciated and fragmented. Five bands of manganiferous quartzite have been mapped. Four bands are identified to south-east of Boringpadar i.e. (i) 150 m x10 m trending NNE-SSW (ii) 230 m x 10 m trending N40^{o}E-S40^{o}W (iii) 150 m x 5 m trending N40^{o}E – S 40^{o}W (iv) 100 m x 5 m trending N-S to N45^{o}E-S45^{o}W. Fifth band has been mapped with dimension 100m x 20m trending N40^{o}E-S40^{o}W towards east of Bagada. Analytical result of BR samples indicates Mn value ranging from 0.05% to 23.78% ,

SiO_2 from 8.45% to 92.12%, Fe(T) from 1.87% to 56.31%, Al_2O_3 from 1.01% to 20.80% and P_2O_5 from 0.77% to 2.81%. The high values of Fe recorded from samples of Boringpadar area and maximum value of Mn come from Amath area. The area can be taken up for delineation of the ore bodies with drilling under G3 level.

During G2 level general exploration for manganese ore in Kutinga block, Koraput district, a total of 233.70 m was drilled in two completed and one partly completed borehole and 80 core samples were collected for chemical analysis. The completed boreholes intersected 3 ore bands with cumulative thickness of 13.15 m at 60 m level and 8 ore bands with cumulative thickness of 37.05 m. The width of individual bands varies from 0.30 m to 12.60 m. The manganese ore is mostly friable and powdery. The investigation is continuing.

A G3 level preliminary exploration was carried out for manganese ore in Anujurhi block in the central sector of the Eastern Ghats Granulite Belt, Rayagada district. An area of 1.5 sq km was mapped on 1:2000 scale. The lateral continuity was established through pitting and trenching for 75 cu.m. The cumulative strike length of the manganiferous ore body is 800 m with an average width of 10 m. The ore zone is fairly continuous with discontinuous/detached outcrops showing varying width ranging from 8 m to 24 m. A total of 151 samples have been collected from the ore zones. Analytical results of 16 bedrock & 10 trench samples indicate Mn (0.25% to 25.29%), Fe (2.27% to 33.97%), P (0.14%-1.65%) and SiO_2(11.56-80.22%). The ore minerals are mainly pyrolusite and psilomelane. Drilling will continue in 2017-18 to delineate the ore body.

A G3 level preliminary exploration for manganese was carried out in Rukunibori-Loharpadar block in the central sector of Eastern Ghats Granulite Belt, district Rayagada. Detailed geological mapping on 1:2000 scale was carried out both in Rukunibori block (0.75 sq km) and Loharpadar block (0.75 sq km.). The manganese ore zone is discontinuous lensoid type, mainly restricted within manganiferous quartzite. The concentration of manganese in the ore zone is varying from south to north in Rukunibori hill. Towards north, the ore is highly friable and alternately laminated with quartzite and having Mn 1.66%-9.45% whereas, in the south the ore is hard and lumpy and are of moderate to good quality having Mn 12.42% - 28.91%. The value of P_2O_5 remains < 3.5% in the area. The manganese ore zone is about 200m in length and width varying upto 10 m. The ore minerals are mainly pyrolusite, psilomelane and cryptomelane. In Loharpadar block, ore zone is confined within the eastern flank of the quartzite ridge located 500 m NNW of Kutingpadar village. The manganese ore is hard, siliceous with intercalations of quartz and it seems to be low to medium grade on visual estimation. Analytical results are awaited. Drilling will be taken up in 2017-18 to delineate the ore bodies.

In Telangana, a G4 level reconnaissance survey for manganese was taken up in Siddapa Gutta between Surgapalle and Ravalpalli areas in the Pranhita Godavari Basin, Bijjur and Dahegaon mandals, Adilabad district. Managanese rich horizons occur as disseminated or irregular patches in gritty/pebbly sandstone of Chikiala Formation. Cryptomelane and Psilomelane are identified as ore minerals. However, the occurrence is not found economically viable and hence no further investigation is proposed in Upper Gondwana formations.

MOIL

During 2016-17, MOIL carried out a total of 2,089 m exploratory dirilling, involving 12 boreholes in 12 maganese ore mines. Among these 12 mines, two mines viz, Dongri Buzurg & Chikla manganese mines are situated in Bhandara district & six mines viz, Kandri, Mansar, Beldongri, Gumgaon, Old Satuk & New Satuk mines were situated in Nagpur district, Maharashtra State. Four mines viz, Ukwa, Balaghat, Tirodi and Sitapatore/Sukli mines are situated in Balaghat district, Madhya Pradesh. The reported reserves/resources of manganese ore as on 1.4.2017 were estimated at 76.49 million tonnes. Ukwa (13.94 million tonnes), Balaghat (24.54 million tonnes), Tirodi (0.82 million tonnes), Sitapatore & Sukli (0.17 million tonnes & 0.16 million tonnes), Chikla (4.82 million tonnes), Dongri Buzurg (10.88 million tonnes), Kandri (8.85 million tonnes), Munsar (5.70 million tonnes), Beldongri (0.22 million tonnes), Old Satuk (0.51 million tonnes), New Satuk (0.03 million tonnes) and Gumgaon (5.85 million tonnes).

RARE EARTH ELEMENTS (REE)

GSI

In Bihar, a G4 stage reconnaissance survey was carried out for REE and Rare Metals in Bihar mica belt within Chhotanagpur Gneissic Complex in and around Simaltala and Katoriya area, Jamui and Banks district. A total of 100 sq km area was mapped on 1:12500 scale, along with bed rock sampling, pitting/trenching and stream sediment sampling, with an objective of assessment of the potentiality of REE/RM mineralisation. REE bearing mineral phase is identified in EPMA and petrographic study. The analytical results of REE concentration revealed REE values of 1 to 919 ppm with an average of 194.83 ppm for bed rock samples and 9 to 1,589 ppm with an average of 238 ppm for stream sediment samples. A total of 72 bedrock samples shows REE concentrations higher than the average upper continental crustal value (146 ppm) and varies from 146.15 to 919 ppm. In 14 bedrock samples, REE concentration is greater than 500 ppm.

In Gujarat, a G4 search was taken up for Rare Earth Elements (REE) and other Rare Metals (RM) in Ambadongar Carbonatite Complex and Saidiwasan area, Kawant taluka, Chhota Udepur district. The work was initiated as G4 stage investigation to explore the occurrences of REE in Ambadongar – Saidiwasan area. During FS 2015-16 and the drilling work had been carried as G3 stage. Large scale mapping of 13 sq km area and detailed mapping of 1.31 sq km were carried out in different blocks of the area. Grid BRS (100 m x 100 m), petrographic samples and XRD samples were also collected. Four phases of carbonatite i.e 1) Ferro carbonatite/Ankeretic, 2) Calcio carbonatite / Sovite, 3)Brecciated carbonatite (Sovite clast>75%), 4) Siliceous carbonatite. The Ambadongar Carbonatite complex is traversed by numerous prominent ferro carbonatite/ankeretic veins, quartz veins and fluorite veins suspected for REE mineralisation. The analytic results of the grid samples show encouraging value for REE concentration. The REE in brecciated carbonatite showed encouraging value ranging from 500 ppm (0.05%) to 11,000 ppm. About 512 m drilling was carried out to know the potentiality of REE in different types of carbonatite and their extension.The zone of carbonatite varies from 50 m to 80 m, average being 75 m. Pyrochlore, sulphide and magnetite with pyrochlore mineralisation are also observed in cores of different borehole. The chemical result is awaited.

In Jammu & Kashmir, a reconnaissance survey was taken up for REE and polymetallic mineralisation in Kaplas Granite and its surrounding metasedimentary rocks in Loang, Sarthal areas of Bani, Kathua district. Reconnaissance survey for REEs and polymetallic mineralisation was taken up by Large-Scale Mapping of 55 sq km area on 1:12000 scale along with detailed mapping of 0.23 sq km. The analytical results are awaited.

In Maharashtra, a G4 investigation was taken up for locating REE and RM mineralisation in Ghuksi granite, Nagpur district. An area of 75 sq km. was mapped on 1:10000 scale. Two major pegmatite bodies was identified. Bedrock and stream sediment samples of granitic and pegmatitic terrain, located north of Ghuksi village have yielded the highest total REE values of 0.612% and 1.23% respectively. These zones are potential for REE and RM mineralisation. In SEM-EDX study REE bearing minerals such as zircon, monazite, allanite, xenotime and apatite were observed.

In Nagpur district, a G3 level preliminary exploration was carried out for REE and RM through detailed exploration (Auger drilling) in Nawegaon-Goreghat Chawari areas. Auger drilling of 601 m was carried out in Junewani, Umri and Nawegaon area. A total of 182 samples were collected. The auger samples were processed by panning to separate heavy fractions, the same were sent to chemical lab for petro-mineralogical studies.

In Sindhudurg district, a G4 stage reconnaissance survey was carried out for delineating REE rich and associated minerals in Kaladgi Supergroup. Large Scale Mapping on 1:12500 scale has been carried out covering an area of 100 sq km. Based on the chemical results of 254 of talus/regolith sample and all 65 panned Stream Sediment Samples (SSS) showing total REE ranging in between 1,000 and 2,243 ppm and 26 samples in between 500 and 1,000 ppm. The rock type is porphyritic granite/ granite gneiss with numerous pegmatite and quartz veins. In SSS, the highest value of total REE is 951 ppm and highest value of Zr is 13,399 ppm. On the basis of anomalous analytical results, 7 sq km area has been demarcated and explored by pitting.

In Meghalaya, a G4 stage evaluation of potentiality of REE was taken up in the area around Bhoilymbong and area between Mynsynghat – Nartiang, Jaintia Hills & Ri-Bhoi district. Large-scale Mapping on 1:12500 scale was carried out covering an area of 26 sq km in parts of Nartiang, Nonglatem, Sohphoh, Mookabeng and Bamkamar area, West Jaintia hills district, Meghalaya.

In Ri-Bhoi district, Meghalaya, a G4 level survey of REE was taken up in the area around Jirang and area between Umsophria-Warmawsaw. Large-scale Mapping of 50 sq km area was carried out. The cordierite gneiss is light to dark grey in colour, medium grained poorly foliated metamorphic rock dominated by cordierite, plagioclase, quartz, garnet, biotite, sillimanite and opaque with accessory minerals zircon, apatite & monazite, constituting the possible REE hosts.

In Odisha, a G4 level preliminary investigation for REE was taken up in the contact zone between Eastern Ghats Mobile Belt and Singhbhum Craton around Kankarkhol in parts of Deogarh district. One hundred sq. km area was covered by large scale mapping on 1:12500 scale. A total of 362 samples was collected for chemical analysis. Analytical results of 70 samples show REE values ranging from 7 to 387 ppm (in 21 samples of nephline syenite), 47 to 552 ppm (in 7 samples of gneisses), 12 to 356 ppm (in 3 samples of associated pegmatites), 215 to 624 ppm (in 3 samples of laterite over gneisses) and 294 to 1,936 ppm (in 5 samples of stream sediments). Abnormally high values of Zr (> 11,000 ppm) are observed in two SSS NE of Samsamara village. Petrography along with SEM-EDX study depicted presence of trace elements like LREE silicates (Ce, La, Nd dominantly) pyrochlores (Nb, Ta, Ti oxides +U & Th), titanite/sphene, zircon, apatite, magnetite, ilmenite in association with nepheline syenite and HREE phosphates & monazite in garnets of sillimanite-garnet-magnetite-quartz schist.

In Uttar Pradesh, a G4 level reconnaissance survey for REE mineralisation was taken up in Bundelkhand Granitoid complex at Bahadur Kalan Sijara Buzurg area, Jhansi-Hamirpur districts. An area of 130 sq km was mapped on 1:12500 scale. Systematic sampling had been carried out along with pitting and trenching and channel sampling. At places older metamorphic and granitoids belonging to the Bundelkhand Granitoid complex (BGC) are exposed in the mapped area. Some of the pegmatites from Lilwa area are magnetite bearing. The maximum total REE in bed rock sample is 731 ppm. Soil samples from the area has indicated REE of 854 ppm.

In Sonbhadra district, a G4 level reconnaissance survey for tungsten and REE mineralisation was taken up in Dudhi Gneissic Complex, Deorhi-Barwatola area. Investigation for tungsten and REE mineralisation was carried out around Deorhi - Sahgora area. Large Scale Mapping of 130 sq km on 1:12500 scale along with bedrock sampling, pitting, trenching was carried out. REE mineralisation in the area is mainly associated with magnetite bearing pegmatite vein which intruded into granite and gneiss. Analytical results indicate total REE ranging from 681 to 1710.55 ppm. Tungsten value up to 25.26 ppm had been observed in pegmatite samples from Deorhi area.

STATE DIRECTORATES

During 2016-17, Directorate of Mineral Resources, Goverment of Meghalaya carried out exploration for Rare Earth Elements in Sung area, Sung Valley, East Jaintia Hills district. The work includes i) Large Scale Mapping in 1:4000 on 3.64 sq km area ii) Small Scale Mapping in 1:50000 on 25 sq km area. Total 55 cu m of pitting & trenches carried out and total 120 samples for geochemical analysis were collected.

STRATEGIC METALS

TUNGSTEN

GSI

In Andhra Pradesh, a G3 stage preliminary exploration for tungsten and Graphite mineralisation was carried out at Chinnagalikonda – Potanvaram in Rampachodavarm taluka, East Godavari district. The work includes 2.60 sq km detailed mapping on 1:2000 scale. Drilling of 1521.10 m in ten boreholes was completed with pitting and trenching, collection of PTS, BRS, core samples, PS, ORM, and EPMA samples. In Chinnagalikonda area, two old workings for graphite have been identified during the FS:2015-16. The old workings have an average length of about 20 m-30 m and width upto 3 m-5m. Graphite mainly occurs in the form of thin stringers, veins, pockets/lenses in graphitic schist/gneiss and khondalite (garnet-sillimanite gneiss) which are the host rock for graphite mineralisation. The graphite is fine grained, amorphous and flaky in nature and the latter having the directional orientation

following the foliation trend. It contains quartz, kaolinised feldspar, garnet and graphite (in volume 10 to 35% VE). Out of 10 boreholes drilled, seven boreholes have intersected the mineralisation at 60 m vertical depth and one borehole intersected at 120 m vertical depth. Drilling established the graphite bearing zone up to a strike length of 470 m with average width of 2.50 m and approximate fixed carbon content of about 10% in the Eastern Block. Core samples as well as the bedrock samples yielded a range of values from 0.07 to 35.83% of fixed carbon. The exploration was dropped owing to forest issue.

In Chhattisgarh, a G4 stage reconnaissance for tungsten and associated mineralisation was taken up in Chiknipani, Mayurnacha area, Jashpur district. A total of 101 sq km was covered by LSM on 1:12500 scale. Scheelite is the source of tungsten. Scheelite occurs as inclusions in quartz-tourmaline vein. The chemical analysis result of trace elements, PGE and REE for the BRS and PTS samples are still awaited. The analytical results for Au of 50 BRS has been received which his less than 0.025 ppm.

In Maharashtra, a G4 stage investigation for tungsten and associated mineralisation was taken up in Navgram area, Gadchiroli district. An area of 75 sq km was mapped on 1:12500 scale. Aerial reconnaissance study was carried out for an area of 150 sq km in and around Navgram. The Sitabai Dongri quartz reef (1.7 km x 5-20 m) was identified as a mineralised zone in which specks and dissemination of chalcopyrite, pyrite, azurite, galena and sphalerite were observed. On the basis of results of chemical analysis from BRS & PTS over 1.7 km strike length a 60 m stretch of quartz reef, east of Navgram was found to be tungsten bearing mineralised zone, showing 255 to 361 ppm of wolframite. A mineralised zone of about 1 km strike length with 5 m to 18 m width in Sitabai Dongri quartz reef (NE of Navgram) which is supported by chemical results of BRS & PTS showing 10 ppm to 0.31% of Cu, 10 to 0.14% of Zn and <10 to 0.14% of Pb. Another basemetal mineralised zone (200 m strike length with 5-10 m width) was identified in northern continuity of Sitabai Dongri quartz reef, showing 520 to 270 ppm of Zn, 280 to 510 ppm of Cu and 260 to 600 ppm of Pb. Au value of 30 to 670 ppb was found in 13 bedrock samples in mineralised quartz reef.

TIN
GSI

In Karnataka, a reconnaissance survey for tin, tungsten, lithium bearing zone was taken up in the granitoids around Jalihalli, Wengalapur, Anandapur and Gopalapur, Raichur district. The Deodurg project was taken up as G4 stage involving 350 sq km reconnaissance survey on 1:50000 scale and 150 sq km on 1:12500 scale by Large Scale Mapping. Bedrock samples, stream sediment samples, trench samples, PCS, petrographic samples were collected for identification of potential zones for Sn, W and Li mineralisation. The area shows low potential with respect to mineralisation of Sn, W and Li as no major pegmatite veins or probable alteration zones were observed. Thin section studies indicate the presence of several REE phases like allanite, monazite, sphene, xenotime etc. in the granites and pegmatites.

VANADIUM
GSI

In Madhya Pradesh, a G4 level reconnaissance survey for vanadium and basemetal was taken up in Mahakoshal group of rocks in Ganeshpur-Rohaniya-Salhana area, Katni district. Geological mapping has been carried out on 1:10000 scale covering an area of 100 sq km. Mineralisation in the area is mainly surficial in nature. Crystals of magnetite observed on the surface of dolomite, pyrite crystals, flakes of chalcopyrite, malachite staining, epidotisation and vug structures were also noticed. Dolomite bands were also identified. However, no prominent evidence of titaniferous magnetite mineralisation was found.

MOLYBDENUM
GSI

In Madhya Pradesh, a G4 level survey for molybdenum and related sulphide mineralisation was taken up in Bundelkhand Granitic Complex in Sandna – Garha area, Chhatarpur district. Molybdenite mineralisation is characterised by studded orange yellow hallows which is due to oxidation followed by leaching of molybdenite. Silver colour chunks of molybdenite along with orange yellow hallow had been noticed within medium grained granite near Bendari village. Disseminated molybdenite within medium grained granite were also noticed near Bendari village.

MECL

In Tamil Nadu, a G3 level exploration for molybdenum was carried out in Mannadipatti Central Block, (Harur Uttangari Belt), Dharampuri district. The Mannadipatti Central Block lies between Mannadipatti North and Mannadipatti South Block in Uttangari sub areas of Harur-Uttangari Belt extending over a strike length of 700 m and is having an area of 0.60 sq km. An area of 0.6 sq km was covered on 1:1000 scale and 7 boreholes were drilled for a cumulative depth of 1221.00 m. Total 528 samples were collected for analysis of various minerals like Mo, Pb,Cu, W, Sn, Ta, Nv, Co. Au, Re, etc. Total resources were estimated at 0.699 million tonnes with 0.031% molybdenum at 0.010% Mo cut off. The resources also included previous estimation made by different agencies in the area.

BEACH SAND/PLACER/COASTAL MINERALS

GSI

The cruise was taken up (by R.V.Samudra Kaustubh) for evaluation of placer mineral resources in the Territorial Waters off Chilka, Odisha. An area of 48 sq km was surveyed during cruise ST-252. A total of 75 LKM bathymetry survey with depth range of 19.0 m to 23.0 m was achieved. A total of 65 vibro-cores was collected and the length of cores varies from minimum of 0.10 to a maximum of 4.28 m. Preliminary visual identification of sediments suggests that the sea-floor of the survey area is dominated by medium to coarse sand with shells and shell fragments.

During preliminary investigations for phosphorites in continental slope off Mangaluru, Karnataka, high resolution multibeam swath bathymetry, sub-bottom profiling, gravity, magnetic and seabed sampling surveys were carried out in an area of 3000 sq km over the continental slope off Mangaluru. Phosphatic materials were recovered in four forms from the grab samples of the sea mount, namely 1-2 mm sized particles in +230 fraction, 3-5 mm sized pellets on Xenophora shells, 5-10 cm sized concretions and as coatings over carbonate materials and as mineralised crust on carbonate rock. EPMA studies on the phosphatized crest and nodules showed up to 32% P_2O_5 enrichment on the crest and 26% in the nodules.

The cruise was taken up for appraisal of phosphorite in the Continental Shelf off Chennai, Tamil Nadu (SR-28), Multibeam bathymetric survey, sub-bottom profiling, gravity survey, magnetic survey and sound velocity profiling were carried out in an area of 1,234 sq km. Sediment sampling was carried out in 100 locations with grab, vibro-corer, spade corer and gravity corer. Dredging was also carried out in one of the potential zones in the area. Sediment sampling was also carried out in 366 sq km area. The phosphorite occurs as irregular masses, nodules, oolites, pellets. The phosphatic material content in the concretions varies from 70% in the survey area of SR-028 and 41% of the samples from the cruise area of SR-020. Quantitative and qualitative analysis of the sediments are being carried out to know the phosphatic content in the sediments.

A preliminary investigation (R.V. Samudra Ratnakar) for rare earth metals & Yittrium (REY) and Seafloor Massive Sulphides (SMS) in and around Alcock Seamount, Andaman Sea was carried out to explore the nature of occurrences of Fe-Mn crusts and also to scan the mounts/ridges in and around Alcock and Sewell rise during the Cruise SR-022. Based on the multibeam bathymetric data acquired through several cruises of RV Samudra Manthan, morphology and size of seamounts in the Sewell Rise, West Sewell Rise, Alcock Rise and Invisible Bank were selected for the preliminary level Fe-Mn crust exploration and the survey covered an area of 2400 sq km. The Fe-Mn crusts or nodules were found along the gently sloping, less sediment-covered areas at water depths between 800 m and 1300 m. The sediment thickness along the mount/rise/ridge was very less and at many places hard rocks are exposed. Mostly the Fe-Mn crusts were exposed and the nodules are seemed to be embedded in the calcareous sand. From the analysis, it is very evident that the Fe-Mn crust enriched with silicates (9.5 to 24.14 wt%). Co concentration of the West Sewell Rise crust is apparently higher than the Invisible Bank crust and it shows a positive correlation with the Mn. The higher concentration of the Co in the West Sewell Rise indicates its economic potential.

A cruise was taken up for preliminary investigations of phosphorites in continental slope off Mangaluru, Karnataka (SR-27). An area of 3000 sq km was covered by high resolution multibeam swath bathymetry, sub-bottom profiling, gravity, magnetic and seabed sampling surveys. Phosphatic materials were recovered in four forms from the grab samples of the sea mount, namely 1-2 mm sized particles in +230 fraction, 3-5mm sized pellets on Xenophora shells, 5-10 cm sized concretions and as coatings over carbonate materials and as mineralised crust on carbonate rock. EPMA studies on the phosphatized crest and nodules showed up to 32% P_2O_5 enrichment on the crest and 26% in the nodules.

During exploration of manganese nodules and study of morphotectonic evolution of Lakshadweep Sea and its significance on Mn nodule growth within EEZ in west of Lakshadweep, Arabian Sea (SR-25), multibeam survey along with sub-bottom Profiling (SBP) and Gravity surveys were carried out within EEZ. A total of 2020 LKM was achieved in an area of 12,500 sq km within water depth from 2788 m to 4249 m. 44 surface sediment samples were collected using Van Veen grab sampler. The seafloor is covered with pale brown to yellow, sticky, moderately to very compact silty clay/clay. Foraminiferas are abundant in the sediments. Top layer (4 to 5cm) comprise very loose and soft clay. Fe-Mn nodules/encrustations of size varying from a few mm to 8 cm were observed on the loose sediment surface. Big nodule of 12 cm x 9 cm x9 cm dimension weigh 1.2 kg. The nodules are mostly black, sub-rounded to round and their surfaces are having dull lustre. Sediments and nodules /encrustations samples have been sent for chemical analysis. The REE for the Fe-Mn nodule is reported as 1161.64 ppm.

The cruise was taken up for evaluation of heavy mineral resources (by R.V. Samudra Saudhikama) in marine sediments off Varkala-Thangasseri, Kerala (SD-273). Investigation was carried out in about 249 sq km area. The area is mainly covered by sand of coarse, medium and fine fractions. Total 71 vibrocorer samples were collected. Heavy mineral studies, Textural analysis, geochemistry and mineralogy were carried out. Major heavy minerals present are ilmenite, leucoxene, silliminate and garnet. Total heavy mineral percentage ranges from 0.2 to 4%. In Trivendrum district (SD -274), an area of 242 sq km lying off Anjengo has been covered during the survey. Total heavy mineral percentage in the offshore samples varies from 0.18 to 4.13% and average heavy mineral percentage is around 1.55%. The heavy minerals present include ilmenite, sillimanite, zircon, rutile, monazite, garnet, leucoxene, kyanite, in economic group. Ilmenite and sillimanite are dominant heavies found in the study area. The heavy minerals are more concentrated in fine fractions.

During preliminary investigation for REE and gold occurrences in the offshore areas between Ponnani and Beypore (SD-26), bathymetric and multi beam survey, gravity core and water sampling were carried out. Bathymetric survey in the area off Ponnani – Beypore was for 238 LKM and covered 368 sq km area. A total of 56 numbers of gravity core samples was collected with a core length of 0.42 m to 2.73 m. Total 126 samples were sent for analysis for REE, Gold and other trace elements and results are awaited.

Coastal

During assessment of heavy mineral resources in the near shore area, off Santapalle - Bodagutlapalem, North Andhra Pradesh Coast, periodic season wise profile measurements are being conducted along the 30 km stretch from Santapalle to Kotta Dibbalapalem, at six stations viz., i) Kotta Dibbalapalem, ii) Badivanipeta, iii) Bodagutlapalem, iv) Allivalasa, v) Potaiah Palem, vi) Santapalle (Chintapalle) to assess the resource potential and characterisation of heavy mineral distribution and mapping of seabed from 0 to 10 m depth. The total non-magnetic heavy minerals wt% along Santapalle - Bodugutlapalem beach ranges from 0.47 to 52.30 wt% with an average of 8.30 wt%. Boat survey up to 10 m depth off Santapalle-Bodagutlapalem coast was carried out over 50 sq km area to understand the heavy mineral occurrence. The grab samples collected during survey revealed that the wt % of offshore non-magnetic heavy minerals viz., ilmenite, rutile, garnet, sillimanite, zircon and monazite varies from 0.5 to 25.94 % with an average of 10.56%.

Reconnaissance survey of heavy minerals occurrence along the beaches and nearshore between Mindhola and Ambika estuaries, South Gujarat with special reference to landforms and sediment characteristics was taken up and systematic collection of samples from beach, berm and dunes has been carried out in approximately 60 sq km of area and 90 samples representing beaches, berm and dunes at 1 km interval has been collected for chemical analysis. The heavies are mostly represented by black sand which varies in thickness from few mms to as much as 30 cms. Their concentration is more in dunes

ascompared to beaches and berm. The heavies present in the vicinity are ilmenite, mica, garnet, rutile, pyroxenes, monazite (in minor proportion) and iron oxides.

In Karnataka, during preliminary survey for heavy mineral occurrences in the near coastal areas of Polem and Tilmati beach, Uttara Kannada district, an area of 20 sq km was covered and systematic sampling from beach as well as the offshore region up to 10 m isobaths was carried out by collecting 32 grab, 10 core (PVC) and 58 beach samples during different seasons of the year. The Total Heavy Mineral (THM) concentration in the area ranges from 0.25 to 13.49 % with an average value of 4.33%. In case of offshore samples, the THM varies from 1.03 to 3.06% with an average of 1.82%. On the beach, the THM varies from 0.25 to 13.49% with an average of 5.83%. The heavy minerals are mainly magnetite, ilmenite, hornblende, etc.

In Dakshina Kannada district, preliminary survey for heavy mineral occurrence in the near coastal waters between Bengre and Thannirbhavi beach has been carried out. The heavy mineral analysis of the samples collected along profile lines indicates enrichment of Total Heavy Mineral (THM) content in Bengere area in the south (varying between 2 and 13%), and a drastic decrease is towards north of the area. In Kasaba Bengre area, THM content varies between 3 and 6.7%, in Bokkapatnam (THM 0.59-1.66%) and near NMPT guest house (THM 0.50-3.55%). Samples collected from beach near Bengere having THM ranges between 7 and 10%, while towards north THM value decreases. Inshore samples collected near Bengere-Thai Bengere area constitute of 0.14–4.40% THM, while towards Thannirbhavi area it slightly decreases. Mineralogical study of heavy minerals shows presence of amphibole, ilmenite, leucoxene as major constituents, followed by minor amount of garnet, sillimanite, zircon, monazite, kyanite, etc.

In Tamil Nadu, systematic seabed mapping from 0 to 10 m water depth, bathymetric survey and seabed sediment sampling has been carried out for evaluation of heavy mineral concentration in the nearshore area between Vijayapathi and Manappad and adjoining coastal stretch in Tirunelveli and Tuticorin districts. Simultaneously, close spaced beach profiling has been carried out. In the study area, a coastal ridge extending from Manappad to Kudangulam in the upland/coast, over which growth/development of sand dunes and beach terraces could be observed. In Sector-I (Manappad – Periya Talai sector), narrow beach of 30 to 110 m width is prevalent in the area. Wide beach development can be seen between Amarapuram and Alagappapuram. Garnet rich beach sand is seen at Toppuvilai, near Periathalai, in Sector-II (Kuttam – Navaladi sector). This sector is characterized by the presence of narrow beaches of 10 m to 70 m width. The heavy mineral concentration in this sector varies from 0.67% to 78.13%. Garnet rich heavy mineral concentration is seen along Kuduthalai area. In Sector-III (Vijayapati – Maraikattuvilai sector), heavy mineral concentration varies from 1.21 to 7.26 wt.%. The sediment samples collected across exposed section of a palaeo-dune in Uvari area show 14.47% & 31.62% of HM wt. % in 0–0.50 m and 0.50–0.66 m levels, respectively.

PLATINUM GROUP OF METALS (PGM)

GSI

In Tamil Nadu, during G4 level reconnaissance survey for Platinum Group of Elements in Samalpatti Complex, district Dharmapuri, a total of 175 sq km area was mapped by large scale mapping on 1:12500 scale. Overall, the area reveals Pt values ranging from 5 to 170 ppb (Average of 12.77 ppb) and Pd values ranging from 5 to 284 ppb (Average of 11.83 ppb). The entire Samalpatti area shows average Pt + Pd values from 10 to 454 ppb (Average of 24.60 ppb).

DIAMOND

GSI

In Andhra Pradesh, a G3 level of preliminary exploration was taken up to assess diamond potential of Tummatapalle kimberlite (P-13), Penna Ahobilam Kimberlite (P-16) and Wajrakarur Kimberlite field (WKF), Ananthapur district. Total 300 tonnes of bulk sample was collected from the Kimberlite body and this bulk sample was processed, which yielded two numbers of diamonds 4643 (1.2 ct) and 4,644 (0.035ct). A new Kimberlite body was located at 470 m west. During further exploration and detailed sampling KIMs were identified and weathered Kimberlite rock with distinct texture was identified in the pits. Detailed geophysical survey was carried over the area and based on the anomaly pattern and resistivity signatures, the inferred dimensions of the concealed Kimberlite pipe is estimated to be around 220 x 170 m, emplaced along an east-west trending fault/fracture/shear zone. In addition, a small concealed pipe (or may be an off-shoot) in the northern part having a dimensions of 70 x 50 m, trending in E-W direction has been found. Two vertical boreholes were drilled. Total 100 tonnes of bulk sample was collected from P-17, and processed

which yielded eight number of diamonds 4645 (0.095 ct), 4646 (0.040 ct), 4647 (0.095 ct), 4648 (0.010 ct), 4649 (0.345 ct), 4650 (1.805 ct), 4651(0.10 ct) and 4652 (0.15 ct) thus establishing the diamondiferous nature of the new body. In pipe 16, 3 boreholes were completed. Detailed mapping has been completed in 1.0 sq km area covering both P-16 and P-17 pipes. The locations of the boreholes and bulk sample pits and trenches have been marked over the detailed maps for kimberlite pipes P-13, P-16 and P-17. Eight no. of boreholes were completed with a total of 804.5 m of drilling.

In Chhattisgarh, a G4 stage search for kimberlite clan rocks was taken up in Mahasamund, Balodabazar and Janjgir-Champa districts. One new ultramafic body was identified in the eastern parts of Junadih (Bamhani) in contact with leuco granite. SEM-EDX study of suspected indicator grains was carried out and the grains were identified as Cr-spinels to Mg-rich chromites, ilmenites, magnetites and garnets. EPMA study reveals the presence of serpentinised olivine, amphibole, chrome spinels, magnetite and carbonate in thin section. Most of the spinels probed were chromites and Mg-rich chromites. The MgO content ranges from 4.87 to 15.24% and Cr_2O_3 from 47.4 to 56.83% in these spinels.

In Mahasamund district, a G4 stage search for kimberlite clan rocks was taken up. Reconnaissance mapping and ground check were carried out in the target blocks on priority basis. Petrological samples were collected and the rocks were identified as suspected lamproite, pyroxenite, gabbro, dolerite and meta dolerite. A total of 35 PCS samples was collected for petrochemical studies. The whole rock and trace element analytical data of samples indicate the rocks belong to mafic and ultramafic clan. A total of 400 stream sediment samples was collected for heavy mineral separation and these were studied under binocular microscope. Selected grains were mounted for further studies under SEM-EDX and EPMA. During FS 2016-17, 310 grains and one thin section of suspected lamproite dyke were analysed under SEM-EDX which include 110 grains of garnets, 21 grains of spinels, Magnesio Chromite (MgO 13.96% Cr_2O_3 57.48%) including one grain with KCR affinity, 159 grains of ilmenite and 20 grains of pyroxene. The mineral phases of suspected lamproite dyke comprise of carbonate, Ti rich phlogopite, diopside, Sr rich apatite; REE-rich phosphates (monazite), chalcopyrite, pyrite, Mn ilmenite, ulvospinel and show affinity towards KCR. In view of the reported incidence of high Mg chromite in west of village Nawadih, further work was carried out in the upstream side and yielded one grain of Magnesio Chromite (MgO 13.96% Cr_2O_3 57.48%) having KCR affinity and also carried out ground geophysical survey by magnetic method to locate concealed Kimberlite Clan Rocks.

PRECIOUS MINERALS

GOLD

The GSI, MECL and HGML were engaged in the exploration for gold during 2016-17. An account of exploration work done by GSI is given in Table-6.

MECL

During 2016-17, in Tamil Nadu, MECL carried out exploration for gold ore in Kempinkote block, Dharampuri district involving: mapping of 0.43 sq km area on 1:1000 scale; drilling-3363.00 m in 10 boreholes sampling and chemical analysis -1639 nos of primary & check drill core samples for gold; 110 nos primary samples for As, Cu, W, Ni, Co & Mo; 55 nos of composite samples for Au & Ag; 40 nos samples for each petrological & mineragraphic studies; 16 nos for XRD studies; 21 nos samples for spectrographic studies and 50 nos for specific studies determination. Estimated about 1.385 million tonnes of gold ore with 2.70 g/t Au at 0.50 g/t cut off under UNFC measured (331) category. This resources include all previous estimations made by different exploration agencies.

In Karnataka, during G2 stage of exploration for gold in Ajjanahalli East block, LSM of 1.00 sq km area on 1:1000 scale, core drilling of 19 boreholes for total meterage of 5061.00 m and collection of 3,346 nos. of primary, check, duplicate half core samples for Au; 151 nos primary samples each for As and Sb; 50 nos. composite samples for Pb, An and Cu; 50 nos. samples for petrological studies; 50 nos. samples for mineragraphic studies; 39 & 50 samples for XRD & spectroscopic studies, respectively; 60 nos. samples for specific gravity determination and one sample for beneficiation has been carried out. About 1.061 million tonnes reserves/resources of gold ore have been estimated with 2.39 g/t Au at 0.50 g/t Au cut off under UNFC indicated (332) category. This included all previous estimations made by various exploration agencies at different time.

INDUSTRIAL MINERALS

The details of exploration carried out for industrial minerals by GSI and Central/State Undertakings during 2016-17 are given in Table - 7.

Table - 6: Exploration for Gold by GSI, 2016-17

State/District	Location	Details of work done	Results obtained/Remarks
Arunachal Pradesh			
Lower Subansiri	Ampuli-Depo-Hullo area	Mapping	A G4 stage (large scale mapping) has been taken up for gold and associated mineralisation in the metasedimentary sequence of Bomdila Group around Ampuli on 1:12500 scale covering 50 sq km. A zone of oxidisation, limonitisation and gossanisation showing variegated colours rich in magnetite was also observed within quartzite (containing thin bands of quartz mica schist) near Ampuli village on Pitapool – Sagali road section. This zone is about 20 m to 30 m wide (out crop width) and about 1 km long. A 30 m wide calc silicate band having specks and streaks of magnetite has been observed near village Depo in a road section. Samples have been collected from this zone for the possibility of any gold or other metal mineralisation.
Andhra Pradesh			
Chittoor	Gutamidapalle block	Mapping, Drilling, Sampling	A G3 stage preliminary exploration for Gold and associated minerals were carried out in this block in southern part of Velligallu Schist Belt. Detailed geological mapping on 1:2000 scale was carried out over an area of 1.7 sq km. A total 52 samples (27 soil and 25 bed rock samples) alongwith 108.4 cu.m of trenching and 116 PTS were carried out from both the blocks. A total of 964 m of drilling in Gutamidapalle North Block and Gutamidapalle Block was carried out, by drilling of six boreholes in Gutamidapalle block and two boreholes in Gutamidapalle North block. Though the boreholes intersected sulphidic silicified zones in meta basalt and meta acid volcanic rocks of the Velligallu schist belt, the chemical analysis of the core samples indicated low incidence of gold mineralisation ranging from 27 to 520 ppb except in one borehole which has analysed average value of 0.930g/t x 2.7 m at a borehole depth of 96.40 m to 99.10 m. EPMA studies indicated that the pyrite, pyrrhotite are the major sulphide phases with arsenopyrite and loellingite. Loellingite contains occurrences of gold and silver occurring as 'invisible gold'.
Karnataka			
Shivamogga & Davangere	Around Yerekatte and Siddapura area	Drilling & Sampling	A G4 stage reconnaissance survey for gold was taken up in this area. Six samples out of 20 collected from Tarlaghatta area have analysed gold value ranging from 28 to 40 ppb. Besides, two BRS have yielded 282 ppb and 30 ppb of Au value. Two Trench samples analysed 60 ppb and 636 ppb of Au. Only one sample of another trench has given Au value of 106 ppb. Apart from this no other mineralised zone is established in the area.

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Table - 6 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
Tumakuru	Ajjanhalli Block-E	Drilling & Sampling	A G2 stage general exploration was taken up in this block. Quartz carbonate veins carry gold mineralisation in the form of auriferous veins. Gold mineralisation is confined to sheared BIF with quartz-carbonate veins/veinlets. Gold grains occur as inclusions in pyrrhotite, arsenopyrite, galena and as stringers and disseminations associated with pyrite, chalcopyrite, sphalerite and loellingite. Total nine boreholes have been drilled to target mineralised BIF band nos. I, IV, V and VI. Chemical analysis results of 3 boreholes have been received from HGML so far. The first borehole has given gold values of 0.8g/t/0.5 m in Band-I, 0.4 to 0.6g/t/1.0 m in Band IV and 0.4g/t/0.5 m in Band V. The second borehole has given average gold values of 0.53g/t/1.5 m to 1.1g/t/1.0 m in Band I, 0.2g/t/1.0 m to 0.6g/t/1.5 m in band IV and 0.5g/t/1.15 m in band VI. The third borehole has given average gold value of 3.1g/t/1.5 m in quartz vein intruded into meta basalt, 0.2g/t/0.5m at closure of Band I and IV, 0.75g/t/4.5m in Band-V and 0.4 to 0.6g/t/0.5m in Band VI.
	Ajjanhalli block-D	Drilling Sampling	A G2 stage general exploration was carried out in this block to intersect the mineralised zones in the Block – D to test the mineralized zones at second level (120 m vertical depth). The block forms the southern continuity of Ajjanahalli main block. Total 2231.70 m of drilling was done in 10 completed boreholes. Out of 10 boreholes, three boreholes have been drilled to intersect the Mineralised Zone (MZ) III and 5 boreholes have been drilled to intersect the MZ-V at second level (120 m vertical depth). One borehole of 327.30m depth was drilled in the SW part of the block on the basis of the GPR survey carried out by M/s Tekrra Vision Pvt. Ltd. Total 733 Nos. of borehole core samples have been sent for gold analysis by fire assay method. Gold analysis of 3 boreholes has been received. In first borehole average gold values of the mineralised zones are 0.20g/t/0.6 m, 0.60g/t/1.50 m and 0.45g/t/2.0 m. In the 3rd borehole gold values are of 0.53g/t/1.50 m and 0.27g/t/1.50 m. The gold mineralisation is epigenetic in nature.

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Table - 6 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
Chitradurga	Paramanahalli Central and North block	Drilling Sampling	G3 stage preliminary exploration for gold was carried out in this block. During earlier work, in central and north blocks, 3 auriferous zones, viz eastern, middle and western, with strike lengths having 250 m, 400 m and 700 m could be delineated by trenching and sampling. Au potential, with an average grade of 1.2g/t over 4 m and 1.6 g/t over 1.33 m has been estimated for the eastern and middle zones, respectively. A prominent 700 m long western main auriferous ore zone with an average tenor of 2.3 g/t Au over 1.26 m, forming the northern extension of main auriferous ore zones in the south block was traced in central block. The Au assay values enrichment is noticed in the central part. The Au values range from 0.10g/t to 9.59g/t over 12 m and 0.44g/t over 5 m from bedrock profile sampling data at 500 m. The above auriferous ore zones suggest the probable extension of the above western main lode to about > 1.8 km. A resource potential of 0.395 million tonnes of gold ore with grade ranging from 0.9 to 4.17 g/t and width ranging from 0.5 to 3 m could be estimated.
Ballari	Around Bagali & Uppanayakanahalli area	Sampling	G4 stage reconnaissance survey was carried out for gold and associated minerals. The exploration work comprised of large scale mapping 100 sq km on 1:12500 scale and detailed mapping of 0.50 sq km on 1:2000 scale**.**The mineralisation in the area is associated with the alteration zones between the schist belt and the BIF as well as the metabasalts of the area. Au values of 30 and 45 ppb are reported from BIF collected from the Huligudda ridge and its extension. However, a value of 125 ppb gold is associated with carbonated metabasalt at 3 km east of Uppanayakanahalli.
Davangere & Shivamogga	Nyamati block	Sampling	G4 stage reconnaissance survey for gold was taken up in this block by reconnaissance mapping (450 sq km) on 1:50000 scale and large scale mapping (150 sq km) on 1:12500 scale**.** A series of old workings, shafts and one adit were observed in the area. The mineralisation in the Kudrekonda area was reportedly associated with the 'Turnbull Reef' which is exposed in the adit. It appears in the adit as smoky sheared quartz vein of 1.5 m width. A mineralized zone (nearly 1000 m length and 500 m width) hosted in andesite which is located at 1.5 km south of Gadikatte. The rock is rich in sulphides which occurs mainly as disseminations and also occurs as thin stringers. Sulphides mainly noticed are pyrites and pyrrhotites. All the samples were processed for the chemical analysis to assess the Au and associated metal content.

(Contd.)

Table - 6 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
Raichur & Koppal	North of Tawargeri areas	Sampling	A G4 reconnaissance survey was taken up for gold and associated minerals in this area. Old working in the form of shafts, inclines, trenches and pits of various sizes have been observed. Most of these workings are excavated either for iron or gold. Au concentration in all 38 samples, ranges from <25 to 74 ppb. Out of 25 BRS analytical results received so far, one sample shows value of Cu as 395 ppm while others range from <10 ppm to 320 ppm. In BRS peak value of Pb is <20 ppm, Zn is 125 ppm, Co is 75 ppm, As is 55 ppm, Cd is 55 ppm, Cr is 75 ppm and Ag is < 5 ppm.
Shivamogga	Sidharahalli block	Mapping, Sampling	A G4 stage reconnaissance survey for gold was taken up in an area of 150 sq km was mapped on 1:12500 scale and collected BR and trench samples for Au and other associated elements. Petrographic, petrochemical and ore microscopic samples were also collected. Four suspected gold ore zones were delineated based on presence of sulphide minerals in north of Kenchapur, west of Bhairapur, south of Siddarahalli and SW of Jambadahalla. The sulphide minerals identified are pyrite, chalcopyrite, pyrrhotite, malachite in association with sphalerite, galena, magnetite and arsenopyrite. Out of analytical results of 110 BRS samples only ten samples have analysed gold values > 25 ppb ranging from 30 ppb - 186 ppb. Values of associated Cu, Zn, Ni, Cr etc are not significant. Out of the analytical results of 50 trench samples only 4 have gold values > 25 ppb ranging from 38-494 ppb.
Tumakuru	Timmanahalli block	Sampling	A G4 stage reconnaissance survey for gold was taken up in this Block. A 230 m zone of carbonatised BIF was traced at the southern part of the block. Two of these samples collected from this zone are reported with gold values 550 ppb and 1040 ppb, respectively. Another sample collected from limonitised BIF in the eastern part yielded 510 ppb Au over a width of 2.4 m.
Kerala			
Malappuram	Omanur area	Sampling	A G4 stage reconnaissance survey for gold was taken up in Omanur area. Surface indication of mineralsation in the form of limonitization box work, shades of reddish yellow and yellowish tint were noticed. Old workings are observed within BIF in the vicinity of surface indication of mineralisation. The analytical data shows that the gold values are in the range from 0.05 to 0.22 ppm.
Palakkad	Around Puzhikkunnu, Chullipara and Anamuli area	Mapping, Sampling	A G4 stage reconnaissance survey has been carried out by large scale geological mapping of 100 sq km on 1:12500 scale. Two zones were identified on the basis of sulphide mineralisation. i) East of Anamuli area, sulphide mineralisation was noticed in a 28 m wide zone for a length of 750 m. Panning of stream sediment samples from this area has yielded two small specks of gold. ii) West of Kanhirapuzha in the quarry section near Pottasseri, number of quartz

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Table - 6 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
			veins of 15-35 cm in wide and 30 to 50 m in length are present within hornblende gneiss. Sulphide mineralisation is seen within quartz veins and in the gneiss hosting the quartz veins in 750 m long and 180 m wide zone. The sulphides are mainly pyrite, chalcopyrite, bornite, malachite and covelite. Galena and beryl is also found within quartz vein and pegmatite. Trenching was carried out in Munnekar, Kalledikode, Pottasseri areas and only one sample from Pottasseri has yielded Au value of 0.08 ppm. Out of 37 groove samples, 26 samples have yielded Au values ranging from 0.06-1.23 ppm, Ag value from 2.4-59.12 ppm and the Cu values ranges from 40-105640 ppm. Analytical result of the samples shows that Pottasseri is a potential area for further exploration for gold.
Wayanad	Around Anjukunnu, Panamaram area	Sampling	A G4 stage reconnaissance survey for gold was taken up around this area. Three old workings have been noticed. Four meta-pyroxenite bodies have been mapped and among them the major one (sulphide bearing) is exposed 400 m east of Anjukunnu for a strike length of 250 m with a width of 30-50 m. The analytical data does not show any encouraging values of gold mineralisation. However, the total PGE content in the ambhibolite exposed near Ullisseri is 229 ppb which is higher than any PGE value so far reported from the area.
Madhya Pradesh			
Katni	Imaliya block Sleemanabad areas	Drilling Sampling	A G2 stage general exploration was taken up for gold, silver and basemetal has been carried out by drilling 963.53 m. Drilling was carried out through six inclined boreholes. Two were drilled at 60 m, one at 90 m and three at 120 m of vertical intersection of potential zone.In this block mineralisation mainly occurs in two types : one is in massive sulphide form and another in vein/ veinlets (Paper thin to cm thick). Massive sulphide mineralisation was found in 40° to 50° with respect to core axis while vein occurs in parallel or at 70° to 80° with respect to core axis. Visually, pyrite, chalcopyrite, arsenopyrite, bornite and sphalerite were identified in the cores. Gold mineralisation is hosted by Dolomite with quartz veins/ veinlets containing sulphide minerals. Analytical results of 8 core samples revealed values of gold (Au) between 2 and 0.27 ppm (analysed by AAS). Ag varies between 50 and 15 ppm.
Sidhi	Chakariya block	Drilling Sampling	A G2 stage general exploration for gold was taken up in this area by drilling. In Chakariya block a total of 855m of drilling was carried out with two boreholes of close spaced drilling (50m borehole interval) and five boreholes of 100m vertical intersection. A total of 50 cu.m trenching was also carried out along the azimuth of boreholes to confirm surface extension of the mineralised zone. The associated sulphide minerals with gold mineralisation include arsenopyrite, pyrite, galena, chalcopyrite and pyrrhotite (at places) as primary sulphides and scorodite as alteration product of arsenopyrite, which has been used as pathfinder mineral for gold. The Au values in 'scorodite' bed rock samples are promising with Au values ranging from 2.06 to 9.16 ppm. Whereas Au values in grey quartz vein ranges from 0.72 to 2.39 ppm. The value of Cu ranges from 5 to 760 ppm, Pb from 5 to 210 ppm, Zn from 5 to 60 ppm, Co from 5 to 50 ppm, Ag from 0.5 to 10 ppm and Ni from 5 to 45 ppm.

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Singrauli	Amalihwa-Hathipathar-Kapurdei area	Sampling	A G4 stage reconnaissance survey was taken up for gold and associated sulphide mineralisation.Two WNW-ESE trending sulphide mineralised zones were delineated in the mapped area in rocks of Parsoi Formation of Mahakoshal Group. Vein type and disseminated style of mineralisation were noted in the mineralised zones. Arsenopyrite, scorodite, galena, pyrite and chalcopyrite are the principal sulphide minerals found in the mineralised zones. Primary ore textures related to open space filling or deposition are common. The propylitic alteration of host rocks can be traced for a few meters around the mineralised quartz veins with no distinct zonation.
Tikamgarh	Bundelkhand granite complex, Gotet area	Mapping	A G4 stage exploration for gold and associated sulphide minerals was taken up in an area. Mineralization in the mapped area is represented either by vein or disseminated type, which includes minerals pyrite, chalcopyrite, malachite, bornite, covellite, magnetite, hematite, pyrrhotite and sphalerite. Profuse sulphide mineralisation is confined within the hornblende granite, which is again controlled by NW-SE and E-W trending shear zone. Mineralisation and its close association with quartz veins and alterations indicate its hydrothermal origin. Field evidence shows that the hydrothermal alteration and sulphide mineralisations are contemporaneous in nature. Alteration associated with mineralisation is manifested by propylitic alteration which is random and sporadic in space. Besides, advanced argillic alteration characterised by pyrophyllite and diaspore is also evidenced in some of the quartz reefs and quartz vein. In this mapped area, incidences of mineralisation are evidenced and values of different elements do not favour anyfurther major exploration activity.
Rajasthan			
Pratapgarh	Mahuri Khera block	Sampling	A G4 stage reconnaissance survey has been carried out in this block for gold and associated base metal mineralisation. Six mineralised zones have been delineated on the basis of surface evidences, which vary in length from 50 m to 180 m and in width from 2 m to 35 m. The fresh sulphide in the form of pyrite, chalcopyrite and bornite are seen as disseminations and stringers along the quartz veins. The mineralisation mainly present at the contact of dolomite and quartz-muscovite schist. Analytical results indicate presence of anomalous copper values ranging from 10 ppm to 0.57% and gold values ranging from <0.050 to 6.24 ppm. At 0.10% cut off a copper zone of width 23 m with average copper content 0.12% has been recorded.
	Mahuri Khera block	Drilling, Sampling	A G3 stage exploration was carried out for gold and associated basemetal mineralisation in this block, Based on surface indications which are in the form of gossan, ferruginisation, silicification, wall rock alternation and malachite/azurite staining. Seven mineralisation zones have been identified in the area. Boreholes at 100 m intervals were planned to intersect the mineralisation zones. All the boreholes made positive intersection and have proved sub surface extension of the surface mineralisation zones. The main sulphide minerals are pyrite, pyrrhotite, chalcopyrite and arsenopyrite in decreasing order of abundance. Analytical results of gold for core samples of 3 boreholes indicate average gold value varies from 0.12 ppm to 0.63 ppm at 0.1 ppm cut off and width varies form 1.20 m to 3.25 m.

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Table - 6 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
Dungarpur	Pal Nithuwa area	Sampling, Mapping	A G4 stage reconnaissance survey was carried out for gold and associated metals mineralisation in this block. Detailed geological mapping on 1:2000 scale with an objective to assess the nature and potentiality of gold and associated metal mineralisation. Cu values ranging from 0.10 to 0.15% have been recorded in samples collected from quartz-tourmaline rock. Corresponding to the high Cu values, Au ranging from 0.14 to 0.19 ppm has also been recorded. Dolomitic marble with oxidised veins bearing malachite and sulphide minerals indicated anomalous Cu values ranging from 0.10 to 0.48%. Cu values ranging from 0.12 to 0.38% have been recorded in samples collected from ferrugenised quartz tourmaline rock, whereas samples from ferrugenised-quartz-tourmaline rock have given 0.18 to 0.23% of Cu.
Tamil Nadu			
Krishnagiri	Maharaja gadai Bargur	Sampling,	A G4 stage reconnaissance survey for gold was taken up between Maharaja gadai Bargur area. Analytical results for Au from all the favorable host rocks viz. BIF, amphibolites and quartz vein show low value of Au except one trench which have given comparatively high values of Au where its concentration reached up to 509 ppb over 0.80 m. The concentration of Cu ranges from 6 to 465 ppm whereas the maximum concentration recorded for Zn is 240 ppb. During SEM studies, two grains of gold (0.5 pm size were identified in one amphibolites sample.
West Bengal			
Purulia & Bankura	Rudra village,	Sampling,	Preliminary search for gold in Singhbhum Group of rocks, in and around Rudra village, was taken up to identify presence of auriferous zones. Analytical results of 31 soil samples yielded significant values of Au ranging between 0.05 ppm & 0.16 ppm. Besides two BRS samples yielded encouraging values of TiO_2 & V, showing 5.04 & 3.84% of TIO_2 and 0.045 & 0.044% of V respectively. Another samples from different rock yielded TiO_2 values of 1.21 to 2.01% and V concentrations of 0.015 to 0.0335% respectively.
Bihar			
West Champaran	Foothills of Siwalik Himalayas	Sampling,	A G4 stage reconnaissance survey for placer gold has been carried out. Among the samples collected from different sampling media (BRS, PTS, SSS etc.), the panned concentrates or heavies of stream sediments and pit samples showed encouraging outcome in the form of a good number (20 to 30) of minute gold grains/flakes and some dusts from 15 kg of bulk samples. Out of a total 189 samples, analytical results of 126 samples revealed that panned concentrates of stream sediment samples yielded a maximum of 5.2 ppm of Au with a mean value of 0.75 ppm and those of pit / trench samples yielded a maximum of 2.97 ppm with a mean value of 0.33 ppm. SEM and petrological studies of gold grains/flakes and heavy minerals separated from major river basins show size variation from 20 to 200 µm.

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Table - 6: (Concld.)

State/District	Location	Details of work done	Results obtained/Remarks
Jharkhand			
Ranchi	Birgaon Block	Mapping, geophysical survey, Sampling	A G4 stage investigation was carried out in this Block. A total of 2 sq km area has been mapped on 1:1000 scale and alongwith geophysical survey for 30 LKM, with PS, BRS, SSS and PTS sampling. The geophysical IP chargeability contour map indicates an anomalous zone of possible sulphide mineralisation at a depth of 25-30 m. Analytical results showed a maximum Au content of 0.25 ppm in BRS and PTS samples.
Saraikela & Kharsawan Ranchi	Around ghagri-Asangrbera-Dubrajpur-Jurgu	Mapping, Geophysical survey, Sampling	A G4 stage reconnaissance survey has been carried out in this areas. A total 100 sq km area was mapped on 1:12500 scale. Gold mineralisation has been observed in brecciated quartzites and quartz veins showing limonitisation, silicification, leaching of sulphides, shearing in the form of brecciation etc. A bedrock sample shows an anomalous concentration of 2.4 ppm of gold. Trench samples yielded gold values ranging from 60 to 320 ppb. Pit samples yielded a maximum value of 110 ppb of Au. Out of 10 panned stream sediment samples, visible specks of gold were recovered in only 3 samples. The total REE value of bedrock samples ranges from 3 to 3363 ppm and three samples showed high value of 3363 ppm, 2673 ppm and 2399 ppm respectively.
West Singhbhum	Tiring-Dubrajpur area	Mapping, Sampling	A G4 stage reconnaissance survey for gold, arsenic and antimony was carried in this area. 100 sq km area has been mapped on 1:12500 scale in the south-western part. Gold mineralisation has been found to be associated with the host rocks, viz., chlorite schist, mica schist, metabasic rocks, brecciated quartzite/ quartz reefs and numerous quartz veins and veinlets of grey to whitish colour and smoky quartz veins. Bedrock samples showed a maximum of 60 ppb of Au value.

Table - 7: Exploration for Industrial Minerals by GSI, MECL & GMDC, 2016-17

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
GSI							
LIMESTONE							
Andhra Pradesh							
Guntur	Tadutla block	1:5000	3	21	1100	-	A G2 stage general exploration was carried out for assessment of cement grade limestone. Drilling was carried out in a grid pattern of maintaining spacing of 350-450 m. Eight bore-holes intersected greyish white to dark grey coloured massive limestone and remaining 13 boreholes intersected variegated brown coloured massisve shaly limestone. The chemical analysis result suggests that the dark grey to greyish white massive limestone variety is of cement grade and the rest is more siliceous which is not suitable for cement. However, some of the samples have CaO value more than 48% and SiO_2>15%. Thickness of cement grade limestone band encountered in boreholes varies from 2 to 28 m. The reserves of cement grade limestone have been estimated at 29.14 million tonnes considering CaO value < 42% and SiO_2 >17%.
Kurnool	CAK block	1:5000	4.5	23	1128.20	-	During G2 stage general exploration drilling was completed for assessment of cement grade limestone. All boreholes have intersected limestone at varying depths. As per chemical analysis results, received so far the limestone is of cement grade with thickness varying from 2 m to 28.50 m. Rest of the limestone including flaggy limestone have higher silica content and not suitable for cement industry. Reserve for Chintalayapalle block has been estimated upto 33.14 million tonnes. Reserves/Resources for remaining two blocks will be estimated after receipt of chemical analysis data.

(Contd.)

Table - 7(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Chhattisgarh							
Kabirdham	Birutola-Nawapara-Sohagpur block	1:4000	2.7	31	950.00	-	A G2 stage exploration was taken up in the area by detailed mapping. A few exposures of stromatolitic limestone have been observed in the periphery of the area and also intersected in most of the boreholes at an average depth of 10 m to 25 m. Besides, core samples, PCS, BRS and XRD samples were also collected.
Rajnandgaon Hanaibandh-	Jagmadwa-Mardkathera block	1:4000	2.8	64	2000	1151	During G2 stage exploration, 60 boreholes were drilled with 30 m average depth each and 4 boreholes with each 50 m average depth. Out of these 64 boreholes,40 boreholes are economically significant. The thickness of limestone varies from 18 m to 24.2 m with less shale partings. Reserves/ Resourceswill be estimated after receipt of analytical data.
Jammu & Kashmir							
Leh and Kargil Ladakh Region	Khangral-Lamayuru area	-	-	-	-	-	A G4 stage reconnaissance survey for limestone of Zanskar basin of Khangral-Lamayuru area was conducted in the area. Limestone is thinly laminated to massive bedded type with thickness 10-20 m. Few beds are also upto 40 m thick. During LSM, 55 limestone blocks had been identified. The limestone of Khangral-Bodhkharbu-Haniskote-Lamayuru area has appreciable value of CaO. The average oxides value of CaO, SiO_2, MgO, Al_2O_3, Fe_2O_3 and R_2O_3 (Al_2O_3+Fe_2O) are 48.82%, 1.00%, 5.35%, 0.97%, 0.75% and 1.72% respectively.
Karnataka							
Belagavi	Hoskoti & Salapur	1:4000	2	-	1054	-	A G3 stage preliminary investigation for SMS grade limestone was taken up by detailed mapping to locate and intersect desired limestone body. All boreholes intersected limestone. Analytical results of a few grey

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Table - 7(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
							limestone and pink limestone samples showed CaO in the range of 42 to 51%. Based on visual estimation and available BRS analytical results, some bands within variegated limestone are likely to be cement grade. Reserves/Resources will be estimated after the receipt of chemical results.
Belagavi	Around Tondikati, Chippalkati and adjoining areas of Yadwad	1:4000	2	-	-	11	During G3 stage preliminary exploration for SMS grade limestone, various litho units like dolomitic limestone, grey limestone, pink & white limestone,purple laminated limestone, banded limestone and variegated limestone were mapped by detailed mapping. Analytical results from Manami block have shown some encouraging results in terms of CaO %. Four samples collected from grey limestone, pink white limestone, banded limestone & variegated limestone analysed CaO > 40%. The average SiO_2 in grey limestone is 24 - 28%, banded limestone 1 - 3% and pink white limestone 3 - 11%. The percentage of Fe_2O_3, Al_2O_3 and TiO_2 is high in grey limestone. Further exploration activities in the area have been closed.
Madhya Pradesh							
Jhabua	Khari-Talawadi-Kherli-Mongra, Block - I (Kheriya-Sejawada-Sanda-Mathana)	1:50000 1:10000	200 100	-	-	-	A G4 stage reconnaissance survey was carried out in parts of Bagh basin. Block-I covered 70 sq km area and divided into five sectors. The central part of block-I namely Khari-Takari, Dabri-Talawadi-Bamanbardi and Kherli-Mogra sectors is probably good host of limestone with thickness of limestone bed varies from 1 to 15 m. Block-II covers about 33 sq km area and is not very promising because the limestone bed is siliceous.
Meghalaya							
East Khasi Hills	West of Ishamati	-	-	8	800	-	During G2 stage drilling for limestone drill cores shows presence of micro fossils and algal matters.

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Table - 7(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
							The thickness of Prang limestone varies from 51.20 m to 78.0 m with average thickness of 66 m. Reserves/Resource estimation will be done after the receipt of analytical data.
	Mynthning block Litang valley	-	-	11	719.80	-	A G2 stage general exploration has been carried out in this block. The thickness of Prang limestone in Litang valley varies from 33 m to 123 m. The limestone is mostly of cement grade with minor amount of SMS(OH) grade. Reserves/ Resources will be estimated after the receipt of analytical data.
East Jaintia Hills	Samasi-Pala block-Litang valley	-	-	8	783.05	184	During G3 stage preliminary exploration, covering an area of a 1.5 sq km. The Prang limestone thickness varies from 52.15 to 108.70 m. The average CaO % in core samples is about 45.52%. Out of the total 184 samples analysed, 49% is cement (Portland/ Blendable/Beneficiable) grade, 16% is SMS(OH) grade, 2% is SMS(LD) grade, 1% is chemical grade and rest is others/ unclassified category. SMS(LD) and Chemical grade are mainly in calcite vein encountered in boreholes at a depth of 22.60 to 42.10 m. Reserves/Resources will be estimated after the receipt of all analytical results.
	East of Laphet 1:4000 area, Litang valley	3	-	-	-	43	A G4 stage reconnaissance survey was carried out in Pala area, east of village Laphet. Analytical results of limestone sample show CaO content vary from 29.81 to 51.28%, Al_2O_3- 0.79 to 6.02%, MgO - 0.34 to 2.39%, MnO - 0.01 to 0.83%, Fe_2O_3 - 0.87 to 26.92% and SiO_2 - 1.84 to 10.57%. Majority of samples result indicates cement grade limestone in the area.

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Table - 7(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
	North of Larket block, west of Litang river	-	-	3	804.9	-	During G2 level general exploration, all boreholes have intersected Kopilli shale with intercalation of fossiliferous marl of 25 m followed by light grey nummulitic limestone (blendable cement grade), light grey to grey fossiliferous limestone followed by solution cavity rich off-white limestone. This limestone analysed CaO > 50% and SiO_2 > 2%. Estimation of reserves/ resources will be carried out after the receipt of analytical results.
Jaintia Hills	Tongseng-Shnongrim block, Litang valley	-	-	-	793	-	G2 level general exploratory drilling indicated the presence of very thick i.e. 113.00 to 126.25 m (avg. 119.91 m) highly fossiliferous limestone.Reserves/ Resources estimation will be done after the receipt of all analytical results.
	Shnongrim-Molasngi block, Litang valley	-	-	-	815.50	-	G2 level general exploratory drilling indicates presence of a very thick, grey, medium grained, highly fossiliferous limestone band. Thickness in boreholes varies from 109.0 to 123.75 m (avg. 117.97 m). CaO content varies from 44.30 to 51.96 wt%, MgO - 1.92 to 2.01 wt% & SiO_2 - 5.70 to 6.49% wt%. Reserves/ resources will be estimated after the receipt of all analytical data.
Rajasthan							
Jaisalmer	Jiraj ka Toba-Asu Tar (Main) block	1:4000	3.06	39	1665	1591	G2 level general exploration for SMS/ cement grade limestone was carried out in the area. The main litho units exposed in the block are hard and compact fossiliferous limestone, ferricrete/ fragmentary ironstone and

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Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
							gritty sandstone.Drillig carried out on a grid pattern of 250 m x 250 m. The borehole depth varies from 30 m to 50 m depending upon intersection of limestone. All the boreholes drilled have intersected hard and compact fossiliferous SMS grade limestone at varying depth. Two types of occurrences of limestone i.e. massive thick band and intercalation with clayey limestone and clay are noticed. Total 1591 core samples submitted for the analysis of major oxides. five samples are submitted for each of petrographic and XRD studies. The analytical results are awaited. Reserves/ resources will be estimated after receipt of analytical result.
Jaisalmer	Ramgarh block	1:4000	2.56	16	800	-	G3 level prelimenary exploration was carried out for SMS/cement grade limestone and to know the further extension of the concealed Khuiala limestone. Drilling in vertical boreholes was carried out at 400 m X 400 m grid pattern. The important lithounits intersected in different boreholes are sandy soil, calcareous clay, pale yellow clayey limestone, bioclastic foraminiferal limestone, chalky limestone, hard and compact limestone, grey clayey limestone and grey shale. Clayey limestone has been intersected in all the boreholes with thickness varies from 0.30 to 6.95 m. This limestone seems physically unsuitable to fit into the SMS grade becuase of poor strenght.Chalky limestone is off-white to pure white in colour with thickness varies from 0.30 to 15.70 m and seems fit well in Chemical grade with 2% silica only. Reserves/ resources will be estimated after the receipt of analytical data of all samples.

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Table - 7(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
	Minyun ki Dani (East) block	1:4000	3.75	81	4,050	716	During G2 level preliminary exploration for SMS/cement grade limestone, various litho units have been intersected in the boreholes, are chalky/ clayey limestone, bioclastic foraminiferal limestone, clayey limestone, variegated sub-bentonitic clay with occasionally well developed crystals of gypsum and pyrite and banded shale. Thin bands of gypcious clay have also been recorded in the northern parts of the area. Clayey limestone in the southern part of the block have been intersected at depth of 1 to 4 m as compared to the northern part where it has been intersected at 15 to 20 m below ground level. In the northern part of the block, bands of hard and compact limestone (expected to be of SMS grade) have been interesected varying in width from 2 to 3 m at a depth of 44-48 m. Thin bands of fragmentary iron stone and gypsum (selenite) have been observed at shallow depth of 2-4 m. In the central part of the block, bands of hard and compact limestone (expected to be of SMS grade) varying in width from 3 m to 5 m have been intresected within the depth range of 19 and 33 m respectively. Analytical results for the core samples of two boreholes have confirmed chemical grade of hard and compact limestone

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Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Jaisalmer	Gorumukhan ki Dani (South) block	1:4000	5.00	29	1350	-	Preliminary exploration was carried out by detailed mapping to know SMS grade limestone. Vertical auger drilling had been carried out in 400 mX400 m grid pattern and generated a total of 716 core samples of chemical analysis. Two prominent bands of hard and compact limestone had been intersected in all the boreholes. The upper band is intersected in the depth range from 5.0 m to 26.0 m, with thickness ranging from 6.60 m to 9.50 m. The lower band is intersected in the depth range from 18.75 m to 35.70 m, with thickness varying from 2.40 m to 5.20 m. The weighted average grade of SMS (LD) grade limestone shows CaO-53.37%, SiO_2-1.92%, MgO-0.49%, Al_2O_3-O.49% & Fe_2O_3-0.81%. The weighted average grade of cement grade limestone shows CaO-47.97%, SiO_2-9.93%, MgO-0.65%, Al_2O_3-0.21% & Fe_2O_3-2.45%.
Tamil Nadu							
Cuddalore	Uchchimedu prospect	-	40	15	-	513	G3 level preliminary exploration for limestone has been carried out to assess the resource in Uchchimedu prospect. A total of 15 numbers of vertical boreholes (65 m depth) were drilled at 500 m spacing to ascertain the extension of limestone zones along and across the strike. The calcareous zone was intersected in all the boreholes. The overburden varies from 9.5 m in the north to 40.13 m in the south along the main base line. A total of 26 numbers trench samples were collected from 3 trenches and the analytical data shows that the CaO% of limestone ranges from 36.14 to 43.41%. The thickness of the calcareous zone ranges from 25.00 m to 45.00 m and it is comparatively lesser in thickness along up dip direction. A total of 487 core samples were sent for chemical analysis. Analytical results for 325 samples show that an average grade of CaO wt% varies from 40.38 to 45.18% for limestone zones. Overall, the entire calcareous zone

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Table - 7(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
							analysed for 38.85% for 36.12 m thickness, indicating the marginal grade limestone. The thickest limestone intersected in boreholes is 34.70 m and 37.57 m with an average grade of CaO of 42.35% and 43.28%, respectively. Reserve/resource will be estimated after receiving the analytical results for all the core samples.
Uttarakhand							
Almora and Pithoragarh	Agalgarh Dhar-Chahaj area	1:12500	130	-	-	-	G4 stage reconnaissance survey was carried out in the area for limestone and magnesite. During Large Sale Mapping, three limestone bands were delineated. i) About 15 km strike length with width varying from 50-300 m. ii) About 400 m thick folded band (3 km unfolded strike length) at the eastern part of the block, at the base of Gangolihat Member iii) 3 km strike length with maximum thickness of 600 m of Gangolihat member were delineated. The XRD analysis of limestone samples from Pabhen area suggests the rock type to be of dolomitic limestone.
Pithoragarh	Gangolihat area	1:12500	150	-	-	-	G4 stage reconnaissance survey was carried out in the area for limestone, magnesite and basemetal. During large scale mapping, two bands of limestone are found to be of promising nature. One is exposed near Rol in the Gangolihat-Rol road section and the second as folded thin band surrounding the slates of Rauthgara Formation. The band near Rol extends over a strike length of 4 km to 4.5 km, having a thickness of 250 m to 300 m. The other band is 15 m to 50 m thick with average thickness of around 30 m. and extends over a strike length of around 11 km. The malachite stains near Kothera, Bora agar and Gharmata showed small patches of mineralised zones with pyrite and chalcopyrite occurrences. Besides, soapstone/talc occurrences have also been observed. Near Bora agar and Gangolihat, patches of magnesite bands have been also noticed. (Contd.)

Table - 7(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
	Pithoragarh area	1:12500	-	-	-	-	G4 stage reconnaissance survey was carried out for limestone and magnesite around Pithoragarh area. Large Scale Mapping has brought out that litho-units comprising dolomite with interbedded phyllite, limestone and magnesite. One limestone band is delineated having strike extension of about 5 km with thickness ranging from 50 m to more than 400 m. Magnesite bodies are present as patches and pockets within dolomite. The XRD analysis of limestone samples from Bisar area suggests that the rock type to be dolomitic limestone.
Pithoragarh and Bageshwar	Berinag area	1:12500	-	-	-	-	G4 stage reconnaissance survey was carried out for limestone and magnesite. A dolomite band was delineated from Dharichurra to Nargoli which stretches for a strike length of about 6 km with limited exposures and shows variable thickness from 200 m to a maximum width of 700 m. Limestone and magnesite bands were not observed in the mapped area. Bed rock, channel and trench samples were collected from the dolomite body for chemical analysis. The results of the chemical analysis are awaited.
GMDC							
Limestone							
Gujarat							
Kachchh	Lakhpat block	-	-	-	-	-	About 1,500 million tonnes of limestone resources were estimated.
MECL							
Limestone							
Chhattisgarh							
Raipur	Nahardih-Madhaipur block	1:10000	5.45	-	-	23	G4 level exploration was carried out to facilitate the State Govt. (Chhattisgarh) in auctioning of blocks. Resources were not estimated.
Madhya Pradesh							
Satna	Naubasta-Kolard Limestone block	1:1000	15	5	294.00	111	Estimated about 198.625 million tonnes of resources with CaO 44.61%, MgO 2.35%, SiO_2 10.52%, Al_2O_3 1.64%, Fe_2O_3 1.32%, & LOI 37.41% under 334 category.
	Jamodi-Mahanna block	1:10000	31	5	274.00	106	Estimated about 297.317 million tonnes of resources with CaO 44.66%, MgO 1.78%, SiO_2 10.82%, Al_2O_3 2.19%, Fe_2O_3 1.45%, & LOI 36.82% under 334 category.

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Table - 7(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Satna	Gunchihai block	1:10000	6.5	5	262.00	104	Estimated about 116.831 million tonnes of limestone resources with CaO 45.48%, MgO 2.31%, SiO_2 10.13%, Al_2O_3 2.09%, Fe_2O_3 1.38%, & LOI 37.91% under 334 category.
Meghalaya							
East Jaintia Hills	Lumshorton block	1:4000	3.54	6	645.20	315	Estimated about 622.994 million tonnes of resources with CaO 50.65%, MgO 1.68%, SiO_2 2.80%, Al_2O_3 0.27%, Fe_2O_3 0.31%, & LOI 41.27% under 332/333 categories. The resources also include earlier estimation made by different agencies.
GSI							
Baryte							
Maharashtra							
Chandrapur	Naleswar-Tukum area	1:12500	150	-	-	-	G4 stage reconnaissance survey for baryte and associated mineralisation was carried out. There are three parallel shear/fault zones, trending NNW-SSE within the Mul Granite, on which the veins of baryte occurs as intrusive. Baryte is associated with sulphide minerals such as disseminated chalcopyrite, chunks of galena and purple coloured crystals of fluorite. This assemblage is seen only in the barite bearing bodies of Naleshwar village. Analytical results show Ba ranges from 41.89 to 58.39%.
Andalusite							
Uttar Pradesh							
Sonbhadra	Pulwar block North of Pulwar village,	1:2000	1	-	1082.15	15	General exploration has been carried out in segment 'A' of Pulwar block. The litho units exposed in the area are andalusite bearing phyllite, granite, intrusive andalusite bearing quartz vein, milky white quartz vein and minor pegmatites. The andalusite crystals are seen as disseminated porphyroblasts within phyllite. The andalusite crystals are long slender, prismatic in shape, with vitreous lusture. Most of the andalusites are of "chiastolite" variety. Analytical values of Al_2O_3 and SiO_2 in 10 BRS ranging from 7.81 to 31.01% and 50.36 to 77.02% respectively. Analytical values of Al_2O_3 and SiO_2 in 05 PTS range from 33.26 to 38.55% and 50.84 to 52.49%, respectively.

(Contd.)

Table - 7(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Andalusite							
Uttar Pradesh							
Sonbhadra	North of Pulwar village, Pulwar block	1:2000	1.5	-	500	22	G3 level preliminary exploration was carried out in segment 'B' of Pulwar block. Andalusite bearing phyllite is the major lithounit in the area. The most of the andalusites are of "chiastolite" variety. Analytical values of Al_2O_3 and SiO_2 in 5 bedrock samples range from 22.74 to 27.28% and 47.42 to 56.85% respectively. Analytical values of Al_2O_3 and SiO_2 in 5 pitting-trenching samples range from 29.80 to 35.80% and 47.95 to 52.49% respectively. Analytical result of 12 core samples shows Al_2O_3 and SiO_2 values from 21.50 to 28.62% and 52.34 to 58.70% respectively.
Quartzite							
Jammu & Kashmir							
Udhampur	Latti, Basantgarh Barrot area	1:12500 1:2000	50 0.2	-	500	-	G4 stage reconnaissance survey in parautoch-thonous zone in Latti was carried out. Bedrock samples collected from the area were sent for major and trace elements analysis. Analytical results are not yet received. The thickness of the quartzite band varies from 12 m to 180 m with a strike length of 12 km. The quality of the quartzite will be known after getting analytical results.
Glass Sand & Quartzite							
Assam Nagaon & Karbi Anglong	Silpata Bamuni Chapanala Borhola block	-	-	4	235.5	104	G3 stage preliminary expolration was carried out to bring out the depth continuity of the silica pontential zone and their resource estimation. Loose buff coloured quartzite with fine to medium grained quartz and minor clay encountred in the area. The chemical analysis indicate SiO_2 ranging form 70% - 93.68%, Al_2O_3 ranging form 3.68% to 24.09% and Fe_2O_3 ranging from 0.51% to 13.73%.

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Table - 7(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Clay							
Tripura	Sonaimuri block	-	-	-	-	-	G4 stage reconnaissance survey of clay horizon was taken up with a view to their possible commercial application. The clay is sheet like deposits, at varying depths from 0.20 to 1.60 m with a varying thickness of 1.00 to 2.00 m in Dukli Block along Haora and Bangeshwar river and its tributaries, respectively. The eastern part of the Dukli Block is drained by (1st, 2nd and 3rd) order streams and which are all joining Bangeshwar river. The flood plain areas along the streams contain clay rich top soil. The clay rich soil in the flood plain area is mainly cultivated for paddy crops and vegetable. The Dupitila formation is characterised by feldspar rich semi consolidated sand and irregular patches of coloured clay which are all occupied by rubber plantations and habitations. The flood plain areas, along rivers and streams have clay horizons especially in central and eastern part of the block. Data from pitting reveal that the plastic clay is in the form of discontinuous lenses and pockets within Quarternary alluvium. The thickness of plastic clay varies from 0.70 to 1.5 m.
Dolomite							
Himachal Pradesh							
Bilaspur	Parnali and Tattapani	-	-	-	-	-	G4 stage reconnaissance survey for low silica dolomite was taken up. During large scale mapping, three bands of dolomite have been delineated. Band L-1: Dolomite band of Parnali Formation is in lensoidal shape and established over a strike length of 13.7 km with average width of about 450 m. Band L-2(A): The dolomite band of Tattapani Formation is exposed at Barog-Ghagas-Bharatu area. The dolomite band is about 430 m in thickness, traced for about 12.2 km Shale parting (2-16cm) has been identified with in the dolomite. BandL-2 (B): The dolomite band (Tattapani Formation) is exposed at Karot-Thanger-Deoli area. The exposed thickness is about 812 m and strike contnuity is about 8.3 km. The chemical analysis is awaited. (Contd.)

Table - 7(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
GSI							
Glauconite							
Bihar							
Kaimur	Adhaura	-	-	-	-	-	G4 stage investigation was carried out for glauconite in south of Adhura. A total of four glauconite mineralised zones have been delineated in Chutia-Tiura, Paruka-Majuraha, Jadunathpur and Belduria-jaradag areas with strike lengths of 3 to 3.5 km, 2 km, 1.3 km and 4.75 km having widths of 50-60 m, 30-500 m, 80-100 m and 80-100 m, respectively. Encouraging analytical results of K_2O% have been obtained, ranging up to 6.97% in bedrock samples of glauconitic sandstone. Three glauconitic siltstone samples from dug wells in Tiura area yielded K_2O values of 13.79%, 13.71% and 13.44%.
Chhattisgarh							
Mahasamund	Saraipalli Bhalukona and Arjunda area	-	-	-	-	53	G4 stage reconnaissance survey for glauconite and associated mineralisation was carried out. Glauconite mineralisation of various sizes and shapes is observed in sandstone and shale of Bhalukona Formation. Glauconite content increases from top to bottom and at the bottom part sandstone appears green due to the higher concentration of glauconite. A total three bands of glauconite bearing sandstone horizons were mapped in Arjunda, Limgaon and Darrabhata areas. Fifty representative BRS samples were collected from the different glauconite sandstone and shale horizons for chemical anlysis, petrographic and petrochemical studies. As per analytical results of three bedrock samples, the K_2O content is found to be high in shale (5.48%) as compared to sandstone (0.95 & 1.58%).

(Contd.)

Table - 7 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Madhya Pradesh							
Singrauli	Bichhiya block	-	2	13	820.3	149	During G3 stage preliminary exploration for glauconite shale/ sandstone, detailed mapping has been carried out. The approximate cumulative thickness of glauconitic shale only, ranges from 0.74 to 5.48 m with an average of 3.11 m. About 149 core samples were collected for estimation of grade of mineralised zone.
Potash							
Punjab Ferozpur	Muktsar and Fazilka	-	-	-	-	-	Reconnaissance survey for potash, phosphate and associated minerals was carried out in Ferozpur. Saltpetre (KNO_3) occurs in the form of thin brittle white encrustations of 1 to 2 mm thickness on older alluvium surface and at some places, it is mixed with soil. In the trenches, saltpetre was observed up to a depth of 60 cm from the surface. Encrustations observed on all wall of trenches and are sporadic in nature. The ground water is mostly alkaline and specific conductivity of the groundwater of the area ranges between 318 and 21,173 micro siemen/cm. Potash ranges between 5-80 mg/1 and nitrate ranges between 2 and 975 mg/1, which is more than the desirable limit at most of the places. This indicates that the area is highly suspectible for salt formation.
Rajasthan							
Hanumangarh	Satipura sub-Basin of Nagaur-Ganganagar evaporite basin	-	-	6	4687.6	-	Preliminary exploration (G3) was carried out for the search of potash bearing mineral in Hanseran Evaporite Group (HEG) of Nagaur-Ganganagar evaporite basin. The rock units are generally horizontal to sub-horizontal in disposition.

(Contd.)

Table - 7 (Concld.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Graphite							
Arunachal Pradesh							
Upper Subansiri	Around Taliha	1:12500	50	-	-	-	G3 stage preliminary exploration by large scale mapping and detailed mapping have been carried out. Graphite schist occurs as lenses and pockets. The patchy outcrops of graphite schist are exposed generally on the hill slopes and cliffs. Three discontinuously exposed lenses of quartz schist hosting graphite schist were delineated in the Taliha-Dupit-Dochuk area as small isolated patches with strike length of 15 - 60 m, which extends discontinuously up to 1.3 km along the strike length varying from 15-25 m. The third lens L-3 occurs at Sichi river in Pakba area and it extends up to 20 m along the strike length. The true thickness varies from 1.8 m (min.) to 6.8 m (max.). Detailed mapping in Dupit area has indicated an enriched zone of graphite schist of over 400 m length with an average width of 20 m.
		1:2000	0.40	-	-	-	
RSMML							
Rock Phosphate							
Gujarat							
Udaipur	Jhamarkotra B, G and E block	-	-	14	2103.20	1191	Total resources estimated as on 1.4.2017 are placed at 45.957 million tonnes including 25.323 million tonnes under reserve category