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(Part- I : GENERAL REVIEWS)

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EXPLORATION & DEVELOPMENT

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GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

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NATIONAL MINERAL POLICY

The Hon'ble Supreme Court in its judgement dated 2.8.2017 in the Writ Petition (Civil) No.114 of 2014 inter alia directed the Union of India to revisit the National Mineral Policy (NMP), 2008 and announce a fresh and more effective and meaningful policy.

In compliance with the directions of the Hon'ble Supreme Court, Ministry of Mines (MoM) vide its Order No. 15/1/2017-MV dated 14.08.2017 had constituted a Committee. The Committee included representatives from Central Ministries, State Governments, Industry Associates, Professional Bodies and it also consulted NGOs and many other Stakeholders. The Committee went about the cosultative process with problem-solving approach and held four meetings wherein exhaustive discussions on the issues raised by the stakeholders were deliberated.

The Committee submitted its report to the Ministry on 31.12.2017. Based on the report submitted by the committee, Ministry of Mines prepared a draft National Mineral Policy (NMP), 2018 and uploaded it on the official website of the Ministry on 10.01.2018 for seeking comments/suggestions from the stakeholders.

Based on the Committee's Report and the inputs received from stakeholders during subsequent consultations, the Ministry of Mines prepared the National Mineral Policy 2019. The Union Cabinet in its meeting held on 28.02.2019 approved the "National Mineral Policy 2019". The salient features of the "National Mineral Policy 2019" are as follows:

- It proposes to increase the production of major minerals by 200% in 7 years. It also proposes to reduce trade deficit in Mineral Sector by 50% in 7 years.
- It aims to attract private investment through incentives like financial package, right of first refusal at the time of auction etc. or any other appropriate incentive as per international practice.
- Introduces the concept of Exclusive Mining Zones having in-principle statutory clearances for grant of mining lease. It also proposes to identify critically fragile ecosystem and declare such areas as 'no-go areas'/inviolate areas.
- It emphasises implementation of all relevant Acts/Rules related to rehabilitation & resettlement and welfare of tribal communities while grant of mineral concessions.
- Encourages States to auction mineral blocks with pre-embedded statutory clearances.
- To institutionalise the mechanism for ensuring sustainable growth of Mining Sector, an inter-ministerial body is proposed.
- Endeavors shall also be made to grant mining the status of Industry.
- In case of small deposits of precious metals and base metals, the establishment of common smelting and refining facilities shall be encouraged.
- It seeks to align downstream regulations for the exploration, development and acquisition of overseas mineral assets for ensuring its adequate supply which are not available in the country.
- It focuses on a long-term export-import policy for the Mineral Sector to provide stability for investing in large scale commercial mining activity.
- Efforts shall be made to benchmark and harmonise royalty and all other levies and taxes with mining jurisdiction across the world.
- It also introduces the concept of Inter-Generational Equity which is also recognised by the Hon'ble Supreme Court in various judgments.

ORGANISATIONS INVOLVED

GSI, 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 2018-19.

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, provides technical consultancy services for conducting feasibility studies, environment impact assessments, environment management plans, etc. ; plays the role of National Repository of mineral data through maintaining a data bank of mines and minerals by developing advanced IT-based Mineral Information System; carries out mining research project on need-based aspects of mining; conducts mineral beneficiation studies, including mineralogical testing and chemical analysis and prepares mineral maps.

A Remote sensing centre has been set up at IBM in 2018. Multi-mineral leasehold maps are updated on ARC-GIS platform. During 2018-19, geo referencing and projection of 539 toposheets in ARC-GIS covering Goa, Andhra Pradesh, Kerala, Rajasthan, Madhya Pradesh, Gujarat, Chhattisgarh, Telangana Tamil Nadu, Odisha, Jharkhand, Maharashtra, Karnataka, Bihar, Haryana, Himachal Pradesh, Jammu & Kashmir States were completed. Vectorisation of 112 toposheets and plotting of 929 mining leases were also completed.

Mineral beneficiation studies were carried out by IBM to encourage value addition, conservation and development of mineral resources. During 2018-19, 50 ore dressing investigations, 33,644 chemical analyses, 2,751 mineralogical examinations and 02 in-plant study were completed.

The Project on Mining Surveillance System (MSS) was undertaken by Indian Bureau of Mines, Ministry of Mines and BISAG (Bhaskaracharya Institute for Space Applications and Geo-informatics) of Ministry of Electronics and Information Technology (MEITY) to develop a system for detection of incidence of illegal mining by use of space technology and Surveillance of area up to 500 m outside the lease boundary to check instances of illegal mining. The deterrence effect of 'Eyes watching from the Sky' would be extremely useful in curbing instances of illegal mining. A total of 52 major mineral triggers in second phase have been detected from the 3,280 plotted leases across the country, out of which 38 have been verified by the State Governments and in 4 cases unauthorised mining activities have been identified.

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. The last National Mineral Inventory (NMI) was updated as on 01.04.2015 for 71 minerals. As a preparatory to updation of National Mineral Inventory (NMI) for 46 major minerals, a National conference was organised by IBM inviting participants from exploration and exploitation agencies, i.e., State Governments, Central Govt. Departments, Undertakings of both Central & State, etc. to sensitise and mobilise the stakeholders to extend the fullest necessary supports & information needed for the NMI. A two-day training-cum-workshop was also organised for inhouse members of IBM in this regard.

GSI

GSI pursued its most fundamental and basic mapping programme of systematic geological mapping in 2018-19 and had completed 9,330.6 sq. km large-scale mapping, 166.8 sq.km detailed mapping and 1,15,697 m drilling as against previous year's achievement of 9,960.51 sq. km large-scale mapping, 112.30 sq. km detailed mapping and 1,29,710 m drilling. Out of the total mappable areas of 3.146 million sq. km of the country, 31,19,080 sq. km has been covered so far by systematic mapping bringing the total coverage to 99.15%.

Resources Established

Mineral-wise total resources augmented by GSI during 2017-18 are serialised below:

1. A total resource of 353.02 million tonnes of iron ore.
2. A total resource of 5.20 million tonnes of manganese ore.
3. Estimated gold ore resource of 1.48 million tonnes.
4. Estimated a total of about 1.26 million tonnes of lead-zinc ore resources.
5. Estimated about 0.04 million tonnes of PGE resources.
6. A total of 0.7 million tonnes of silver ore resources were estimated.
7. Estimated a total of 22.24 million tonnes of copper ore resources.
8. Estimated a total of about 1.19 million tonnes of REE resources.
9. Gallium resources estimated were at 20.83 million tonnes.
10. Graphite resources estimated were at about 7.29 million tonnes.
11. A total of 28.50 million tonnes of bauxite resources were estimated.
12. Estimated 2,818.71 million tonnes of limestone resources.
13. Andalusite resources estimated were at 34.03 million tonnes.
14. Potash resources estimated were at 147.72 million tonnes.

Marine and Costal Survey

Marine Survey

Offshore geoscientific studies both in Exclusive Economic Zone (EEZ) and Territorial Waters (TW) of India was continued by GSI.

Marine and Coastal Survey Division (M&CSD) has completed the seabed mapping of 1,32,585 sq. km out of 1,50,000 sq. km in 5 km x 2 km grid within Territorial Waters (TW) and 18,67,199 sq. km in the Exclusive Economic Zone (EEZ) beyond Territorial Waters on reconnaissance scale. The total EEZ coverage including TW is 19,99,784 sq. km out of a total EEZ area of 20,14,900 sq. km. During field session 2018-19, R V Samudra Ratnakar undertook bathymetry (11,575 lkm), swath bathymetry (24,676 sq. km), magnetic (6,167 lkm), gravity (20,125 lkm), multi-channel seismic (2,040 lkm), sub-bottom profiling (4,212 lkm) and systematic coverage within TW by coastal vessels of 1,400 sq. km and parametric surveys within TW that included bathymetry (4,538 lkm), shallow seismic (1,522 lkm) and magnetic (2,415 lkm). Marine geoscientific programme taken up comprised eight cruises onboard RV Samudra Ratnakar in deep waters and in the shallow water domain, seven cruises onboard RV Samudra Kaustubh and RV Samudra Shaudhikama each. Besides, two coastal items using mechanised boat and two RP items were also taken up during the period 2018-19.

The following marine geoscientific surveys were carried out during 2018-19 field season:

R V Samudra Ratnakar

Cruise SR-041: Study of Morphological and Tectonic setup along with Geology of North Andaman Sea within EEZ of India

Cruise SR-044: Study of the tectonic setup of Bay of Bengal and Andaman-Nicobar subduction complex within EEZ of India by systematic multi-channel seismic survey.

RV Samudra Kaustubh

Cruise ST-266: Systematic Shallow Seismic Surveys within the Territorial Waters in the Shelf Area of Digha and Sagar Island, West Bengal.

Cruise ST-269: Geophysical Surveys within the Territorial Waters off Gangapatnam, Andhra Pradesh Coast, Bay of Bengal.

Cruise ST-271: Geophysical Survey (Magnetic) within the Territorial Waters off Nizampatnam, Andhra Pradesh Coast, Bay of Bengal.

RV Samudra Shaudhikama

Cruise SD-283: Multi-thematic Mapping of Contiguous Zone beyond Territorial Water in the Arabian Sea off Talikulam, Kerala.

Cruise SD-284: Multi-thematic mapping of Contiguous Zone beyond Territorial Water in the Arabian Sea off Cochin, Kerala.

Coastal Programmes and RP Items

Item-120: Identification of Phosphatic Nodules, Facies Characteristics, Geochemistry and Genesis of Phosphatised Carbonate Nodules and Marine Phosphorites on the Continental Shelf off Chennai.

Item-119: Geochemical Characterisation of Offshore Garnets in East and West coast of India with special emphasis to Rare-earth elements & Trace metals.

Airborne Geological Survey

GSI pursued airborne geophysical survey for generating database by employing magnetic and radiometric techniques through Twin Otter Airborne Survey System (TOASS). 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.

Airborne magnetic & radiometric surveys over Alwar, Neem Ka Thana area, parts of Rajasthan, Haryana and Uttar Pradesh were carried out with an objective to acquire baseline aero-geophysical data and to delineate prospective mineral potential zone. The integrated analysis of aeromagnetic data along with derivative maps have enabled to draw a few inferences from mineral prospecting point of view: (i) The area between Dudu and Reengus seems to be potential for base metal and polymetallic mineralisation. The concealed causative body of intrusive nature extending from deep to shallower part appears to be associated with albitite-mafic rocks; (ii) the area enclosing Kanawat-Dudawas-Ajeetgarh-Chomu-Kaladera-Reengus and Kalawar-Chomu-Shahpura-Chandwaji-Jamwa-Ramgarh, mostly covered by sand, appears to have potential for base metal investigation as it is in continuity or in the vicinity of base metal occurrences associated with the Delhi Supergroup around Neem Ka Thana and Dudawas in the Khetri, and Parallel belts in the Alwar basin; and (iii) Several concealed ring/oblong structures delineated in the Tilt derivative map have shown their association with known intrusive bodies within the formations of DSG in the Alwar-Khetri basins in the vicinity of base metal occurrences. The overall analysis of spectrometric data with the help of K, U, Th and ternary image map have shown association of i) anomalies of high concentrations of K, Th and U with the litho-units of Sandmata Complex and the associated older granites, ii) various formations of DSG in NDFB with potassium anomalies of high concentrations and iii) Post-Delhi intrusive bodies (granitoids and pegmatites) in the NDFB with anomalies of all three elements (K Th and U). Therefore, the association of K anomalies of higher concentrations with the metasedimentary formations or along the contact between the formations and in the vicinity or associated with the Post-Delhi granitoids and pegmatites have to be examined for alteration zones that may be important for mineralisation. The multisensor aerogeophysical survey over Obvious Geological Potential (OGP) and adjoining areas of blocks 1 to 4 in parts of Rajasthan, Gujarat, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Maharashtra, Bihar and Jharkhand was initiated in 2017. Interpretation of aero-geophysical data with the already available geological, geochemical and ground geophysical data has brought out several prospective mineral potential zones. Data for Block 3 is being processed and interpreted. In Block-1, a total of 52,700 sq. km area were covered in parts of Rajasthan & Gujarat. Concealed ring-like structure similar to that at Siwana identified in the northern part of the survey area is delineated. A total of 16 mineral prospective zones have been delineated. Futher exploration programme will be launched in these prospective zones. In Block-2, a total of 43,822 sq. km area were covered in parts of Uttar Pradesh and Madhya Pradesh. New locations for potential kimberlite pipes were identified in the area SW of the Majhgawan diamond mine. The western extension of the Sonrai Basin under Vindhyan cover was inferred. A new basin structure was interpreted along the same trend as that of Sonrai and Bijawar basins, approximately 40 km ENE of Bijawar Basin. A total of 12 mineral prospective zones have been delineated. In Block-3, the data acquisition over an area of 39,144 sq. km covering parts of Uttar Pradesh, Madhya Pradesh, Bihar and Jharkhand was completed. The study of data is in progress. In Block-4, the data acquisition over an area of 44,861 sq. km covered in parts of Uttar Prdesh, Madhya Pradesh, Bihar and Jharkhand was completed. Twenty-nine prospective mineral potential zones for different commodities (metal, industrial & fuel) have been delineated.

MECL

The highlights of exploration carried out by MECL during 2018-19 are summarised as below:

i) The Company has carried out 6.10 lakh metre of exploratory drilling for various minerals, out of which 5.63 lakh metre were through departmental resources and about 0.48 lakh metre through outsourcing.

ii) A total of 128.72 sq.km area have been covered with detailed geological mapping for various minerals in different parts of the country. Besides, 3.59 lakh metre of borehole geophysical logging also were carried out.

iii) In laboratories, a total of 94,516 samples were analysed for chemical analysis and 987 samples for microscopic and petrographic studies.

iv) A total of 39 geological reports of detailed exploration, geophysical survey, environmental & remote sensing studies for different minerals were submitted which led to addition of 8,002 million tonnes of mineral resources during the year 2018-19.

v) The mineral-wise details of resources estimated by MECL are as under:

- Andalusite—A total of 11.80 million tonnes of andalusite were estimated in Garhwa district, Jharkhand.
- Bauxite—A total of 1.65 million tonnes of bauxite ore resources were established in Kabirdham district in Chhattisgarh and Gumla district in Jharkhand.
- Coal—A total of 7,226.60 million tonnes of coal resources were established in Kamptee, Badner, Mand Raigarh, Tatapani Ramkola, Godavari valley, Jharia & Singrauli Coalfield in the States of Andhra Pradesh, Jharkhand, Chhattisgarh, Maharashtra and Madhya Pradesh.
- Gold—About 2.304 million tonnes of gold ore resources were established in KGF, Karnataka.
- Iron Ore— A total of 107.00 million tonnes of iron ore resources were established in Jumka Pathriposhi, Sundargarh district, Odisha and Jhunjhunu & Sikar districts, Rajasthan.
- Lignite— A total of 246.82 million tonnes of lignite resources were established in Tamil Nadu.
- Limestone—A total of 397.31 million tonnes of limestone resources were estimated in Raipur district in Chhattisgarh and Gothra Parasarampur in Rajasthan.
- Potash— A total of 8.56 million tonnes of potash resources were estimated in Jaitpur, Bikaner district, Rajasthan.

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 multidimensional 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 & 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 licence.

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 has been increased from 7 years to 8 years and for offshore it has been increased from 8 years to 10 years.

As part of the Government's effort to increase domestic production, Discovered Small Field (DSF) Policy was introduced for fast-tracking the monetisation of un-monetised small fields/ discoveries of National Oil Companies (NOCs) under Nomination regime and relinquished discoveries under the PSC regime. Some of the notable features of DSF bid in addition to HELP features are: (i) the inclusion of the criterion No prior technical experience required–this would enable ease of entry for non-E&P players; (ii) No upfront bonus; (iii) Exploration allowed during the entire contract period; and (iv) Ready availability of nearby processing facilities. DSF Bid Round-I was launched in 2016 which was a roaring success. Seeing

the success of DSF Round I, DSF Round-II was launched in 2018 with 59 discoveries on offer with an in-place volume of 190 million tonnes of oil and oil equivalent gas.

During the year 2018-19, ONGC has made 13 discoveries (8 inland and 5 offshore). It has monetised 5 discoveries during the year.

During 2018-19, a cumulative of 11,66,279 LKM of 2D seismic and 3,09,992 SKM of 3D seismic have been acquired and 6,887 exploratory wells have been drilled by PSUs. Indian private Exploration & Production companies (E & P) acquired a cumulative of 1,28,944 LKM of 2D seismic and 1,09,471 SKM of 3D seismic data and drilled 372 exploratory wells. Foreign companies have carried out 64,790 LKM of 2D seismic survey, 22,143 SKM of 3D seismic survey and drilled 249 exploration wells.

Ultimate reserves of oil and oil equivalent of gas (O+OEG) established by ONGC, OIL and Pvt./JVs under PSC and CBM regime as on 01.04.2019 are placed at 4,322.25 million tonnes. During 2018-19, accretion in ultimate reserve has been 131.37 million tonnes of O+OEG.

The area-wise development of drilling wells & meterage drilled by ONGC, OIL and private/joint ventures/NOCs are furnished in Table-1 and exploratory efforts in nomination & PSC regime by ONGC, OIL and private/joint ventures/NOCs are enumerated in Table-2.

Details of oil and gas discoveries made during 2018-19 are furnished in Table -3.

Shale Gas

Shale gas and Oil exploration policy was announced on 14th October, 2013 by the Govt. of India for National Oil Companies to explore and exploit shale oil and gas resources in nomination areas. As per policy guidelines ONGC and OIL were supposed to carry out exploration in their PML and ML area in three phases. As per policy guidelines, ONGC and OIL India Ltd have to carry out Shale Gas and Oil exploration in 50 and 6 blocks respectively for assessment under Phase-I. ONGC identified 50 blocks in 4 basins viz. Assam, KG, Cauvery & Cambay basin in Phase-I and OIL identified 6 blocks in 2 basins viz. Jaisalmer and Assam basins in Phase-I. At the end of phase-I, out of the 22 wells in 18 blocks in four basins drilled by ONGC, 5 are exclusive shale gas wells. OIL has drilled 1 well in 1 block at the end of Phase -I. Government of India has approved the policy to permit exploration and exploitation of unconventional hydrocarbons under the existing Production Sharing Contracts (PSCs), CBM contracts and Nomination fields to encourage the existing Contractors in the licensed/leased area to unlock the potential of unconventional hydrocarbon in existing acreages.

Table - 1: Area wise Development of Wells & Meterage Drilled by ONGC, OIL & Private/ Joint Ventures/NOCs, 2018-19

Agency	Onshore		Offshore		Total	
	Wells (Numbers)	Meterage (in '000)	Wells (Numbers)	Meterage (in '000)	Wells (Numbers)	Meterage (in '000)
A. ONGC (Nomination)	305	565.96	106	245.87	411	811.83
B. OIL (Nomination)	22	78.98	-	-	22	78.98
C. Private/JVs/NOCs	122	20.04	8	148.99	130	169.03
Total	**449**	**664.98**	**114**	**394.86**	**563**	**1059.84**

Source: *Directorate General of Hydrocarbons Annual Report, 2018-19.*

Table - 2: Exploratory efforts by ONGC, OIL & Private/Joint Ventures/NOCs, 2018-19

Agency	Onshore		Offshore		Total	
	Wells (Numbers)	Meterage (in '000)	Wells (Numbers)	Meterage (in '000)	Wells (Numbers)	Meterage (in '000)
A. ONGC (Nomination)	60	152.19	29	85.97	89	238.16
B. OIL (Nomination)	11	29.428	-	-	11	29.42
C. Private/JVs/NOCs	18	45.46	8	26.42	26	71.88
Total	**89**	**227.07**	**37**	**112.39**	**126**	**339.46**

Source: *Directorate General of Hydrocarbons Annual Report, 2018-19.*

Table - 3: Oil & Gas Discoveries made by ONGC, OIL, Vedanta Ltd & Pan India Consultant Pvt. Ltd During 2018-19

Name of Basin	Well Name	Name of ML	Oil/Gas
A. ONGC			
Assam & Assam Arakan Basin	Rokhia-75(ROBE)	Konaban PML	Gas
Assam & Assam Arakan Basin(Assam Self)	Jantapathar-1_z	Golaghat Extn-IIAPML	Gas
Assam & Assam Arakan Basin(Assam Self)	Babejia-2	Golaghat Extn-IIAPML	Oil & Gas
Bengal Purnea Inland Basin	Ashoknagar-1	WB-ONN-2005/4	Gas
Kutch offshore Basin SW	GKS091NFA-1	GK-OSN-2009/1	Gas
Krishna-Godavari Offshore Basin	KGD982NA-P1-S-1	KG-DWN-98/2	Gas
Krishna-Godavari Inland Basin	Suryaraopeta west-1	Malleswaram PML	Oil & Gas
Krishna-Godavari Inland Basin	Bantumilli North-2	Malleswaram PML	Oil & Gas
Krishna-Godavari Offshore Basin	GS-29-15-AM-Shift	GS-29 EXT PML	Oil & Gas
Krishna-Godavari Offshore Basin	KGD982NA-M 6	KG-DWN-98/2	Oil & Gas
Vindhyan Inland Basin	Hatta-2	VN-ONN-2009/3	Gas
Mumbai Offshore Basin	B-203-2	NWMH PML Extn	Oil & Gas
B. Oil India LTD.			
Assam Shelf	Dhakuwal-1	Tinsulia PML	Gas
Assam Shelf	West Lohali-1	Hugrijan PML	Gas
Krishna-Godavari Inland Basin	Thanelanka-1	KG-ONN-2004/1	Gas
B. Vedanta Limited			
Rajasthan-Barmer	N-I-North	RJ-ON-90-1	Oil
Krishna-Godavari Basin	H-2	KG-OSN-2009/3	Oil & Gas
Krishna-Godavari Basin	A3-2	KG-OSN-2009/3	Oil & Gas
C. Pan India Consultants Pvt.Ltd.			
Cambay Basin (NELP)	Well-3	CB-ONN-2010/5	Oil

Source: *Directorate General of Hydrocarbons, Annual Report 2018-19.*

Coal

The agencies engaged in exploration for coal during 2018-19 were mainly GSI, CMPDI, SCCL, DGM Odisha and MECL.

GSI

In Chhattisgarh, a G2 stage exploration for coal was carried out in Jobro east block, Mand-Raigarh Coalfield, Raigarh district. During the study, an area of 5.00 sq. km was mapped on 1:10,000 scale and 5 boreholes to a cumulative depth of 3,633.00 m were drilled. Seven regional Barakar coal seams/zones were intersected at depths between 273.85 m and 732.40 m. Thickness of individual coal seam / zone varies from 0.90 m (Seam III) to 39.90 m (Seam VI+VII, MRJE-1, in 3 splits) and cumulative coal thickness varied from 48.35 m to 58.30 m. Seam zone VI+VII is the thickest one and was intersected at depths between 339.60 m and 547.75 m in Boreholes No.4 and Borehole No.2, respectively. Three coal seams were intersected within Raniganj Formation. Besides, a few local coal seams were also intersected within Barren Measures. Regional Barakar coal seams /zones have been traced for about 3 km along strike and 3.5 km along dip direction. The project will continue in field season 2019-20. In Raigarh district, G2 stage exploration for coal in Kida block, Mand-Raigarh Coalfield was carried out comprising Large-Scale

Mapping of 3.00 sq. km areas on 1:10,000 scale and total drilling of 3,041 m in 4 boreholes. Twelve regional Barakar coal seams / zones (Seam I to X, XII and XIII in ascending order) were intersected between the depths of 76.25 m and 804.90 m. The cumulative thickness of individual coal seam / zone varied from 0.72 m (Seam VIII, MRKD-1) to 28.67 m (Seam IV, MRKD-1A). Seams IV & I were found to be the thickest and were persistently intersected in all the completed boreholes. Seam-IV has in multiple splits whereas Seam-I developed in single spilt and was intersected between the depths of 502.73 m and 804.99 m. Barakar coal seams / zones extend for about 2.5 km along strike and 1.5 km along dip direction. The exploration will continue in field season 2019-20.

In Bihar, during G2 stage general exploration for Gondwana coal under the cover of younger formation of Lakshmipur block, Rajmahal Coalfield, Bhagalpur district, an area of 5 sq. km was mapped on 1:10,000 scale and a total of 5,369.70 m have been drilled in 13 boreholes. Coal-bearing horizon in this Lakshmipur block is confined within Barakar Formation only. Four regional Barakar coal seam zones (A, B, C & D in ascending order) were intersected in the boreholes. The total cumulative coal thickness reported in three boreholes was 519.55 m with thickest coal seam of 11.65 m being encountered at a roof depth of 278.90 m. Coal Seam Zone B having the highest cumulative thickness of 115.45 m is the most important for their regional persistence and thickness.

In Madhya Pradesh, G2 stage regional exploration for coal in Sarai-Uphradol block, Singrauli coalfield, Singrauli district was carried out involving a total of 3,533.60 m drilling in six boreholes. The intersected thickness of Raniganj formation in borehole is 85.80 m. The intersected thickness of Barren Measures ranges from 171.80 m to 282.21 m whereas in Barakar formation it varies from 377.27 m to 437.80 m. Intersected thickness of Talchir Formation is 20.63 m. Seven regional Barakar coal seams intersected in most of the boreholes were between the depth ranges from 245.50 m and 540.76 m. The cumulative coal seam thickness varied from 7.75 m to 18.39 m whereas thickness of individual coal seam ranged from 0.59 m to 4.52 m. The continuity of coal seams has been established nearly to about 6.70 km along the strike and about 3.40 km along the dip direction within the block.

In Chhindwara district, a G3 stage regional exploration for Coal was carried out in Kahua-Khireti sector, Pench Valley Coalfield. Exploration comprised mapping of 22 sq. km area on 1:10,000 scale and drilling of 5 boreholes to a cumulative depth of 2,520.25 m (Two boreholes are in progress). Two boreholes were closed within Talchir Formation while one borehole was closed within Barakar Formation and two boreholes were found passing through Barakar Formation. Five regional Barakar coal seams (Seam-I to V in descending order), with cumulative thickness ranging from 15.35 m to 15.55 m, have been intersected between the depths of 448.40 m and 589.25 m. Individual seam thickness varied from 0.69 m to 6.97 m. Seam IV was the thickest seam (5.85 m to 6.97 m) in the area. Seam-III generally was found to occur in two to three split sections. The exploration will continue in field season 2019-20.

In Odisha, G2 stage general exploration for coal was carried out in Kendudihi block, Ib-river coalfield, Sundargarh district. The exploration involved a total of 2,662.50 m drilling in 5 boreholes (drilling in 2 boreholes is in progress), and a total of 435.56 m coal sample have been collected. The boreholes intersected Raniganj (max.: 91.35 m), Barren Measures (max.: 212.75 m), Barakar (max.: 447.04 m) and Karharbari (max.: 14.50 m) formations and basement rocks (max.: 7.05 m) successively from top to bottom. The exploration work has established the occurrence and continuity of two regional coal seam zones of Raniganj Formation, i.e., R-II, and R-I (from top to bottom) and four regional coal seam zones of Barakar Formation, i.e., Parkhani, Lajkura, Rampur and Ib (from top to bottom). Rampur seam zone being the thickest among the Barakar is important from coal resource point of view. Continuity of regional coal seam zones of Raniganj and Barakar Formations about 2.5 km along strike and 2.5 km along dip direction has been established. In Angul

district, G2 stage general exploration for coal was carried in Khandanal block, Talcher coalfield. During exploration, an area of around 4.00 sq. km was mapped on 1:10,000 scale and a total of 1800.10 m were drilled in three boreholes. The lithounits of Kamthi formation (max. thickness 164.17 m), Barren Measures Formation (max. thickness 133.17 m), Barakar Formation (max. thickness 376.06 m) and Karharbari Formation (max. thickness 51.80 m+) were intersected downward sequentially in the borehole. Coal seam zones only have been intersected in Barakar Formation and no coal seam have been intersected in Karharbari Formation so far. Eight regional Coal Seam Zones (II to XI in ascending order) having cumulative coal thickness of 166.27 m were intersected between the depth ranges from 224.09 m to 609.18 m in Barakar Formation. Sub-surface data of the block and adjoining area suggests that the cumulative coal thickness gradually decreased from south to north direction. Coal seam zones are generally associated with fine clastic rich sediments, such as, carbonaceous shale, grey shale& siltone etc. The exploration will continue in the field season 2019-20.

In Nagaland, G4 stage reconnaissance survey for coal was taken up around Mongchen, Dibuia, Waromong and Molungyimsen area, Mokokchung district. During survey, Large-Scale Mapping of 50 sq. km was carried out on 1:12,500 scale to delineate and assess the potentiality of coal in the area. Pitting & trenching of 30 cu. m has been carried out to establish the strike continuity and depth persistence of the coal seams. A total of 5 coal samples were collected for petrographic studies and 5 shale samples adjacent to the coal beds were collected for REE analyses. The coal seams observed to the west of Yimchenkimong and Molungyimsen seam to be the most promising in the study area. The strike continuity of the coal exposure is about 15 m in length with a thickness of about 2 m.

In Telangana, G3 stage preliminary exploration for coal was carried out in Sambayagudem block, South-eastern part of Godavari Valley Coalfield, Bhadradri- Kothagudem district. An area of 25 sq. km was mapped on 1:10,000 scale and drilling of 1,954.70 m of drilling in four borehole was completed. Barakar and Lower Kamthi Formations are coal-bearing in the area. Five numbers of Lower Kamthi coal seam zones have been intersected in the boreholes between the depth range of 245.65 m and 470.40 m with individual coal thickness varying from 0.50 m to 1.45 m. The two Barakar coal seam zones have been intersected in the boreholes between the depth range of 475.11 m and 671.20 m with individual coal thickness varying from 0.50 m to 1.18 m. The quality of coal is mostly of Power grade to Superior grade coal. The exploration will continue in field season 2019-20.

In West Bengal, G4 stage reconnaissance survey for assessment of coking coal & coal-bed methane within Barakar Formation and shale gas potentiality was taken up in Barren Measures in Palasdiha area, Raniganj Coalfield, Barddhaman district. A total of 692.70 m of drilling were completed in one borehole. The entire litho-column drilled belong to Raniganj Formation only. Rocks of Raniganj Formation host several regional coal seams / seam zones ranging in thickness from 0.50 m to 2. 95 m in the depth range of 50.20 m to 594.60 m with a cumulative thickness of 20.63 m intersected in the drilled borehole. Several brown lamprophyre sills with thickness ranging from 0.04 m to 1.58 m have been encountered at different depths. The project will continue in field season 2019-20.

Directorate of Geology, Odisha

Exploration for coal over an area of 7.56 sq. km was continued from previous field session in Madhupur block of Ib Valley coalfield, Jharsuguda district. A total of 1,472.00 m drilling in 7 boreholes and sampling of 257.94 m core were carried out during the year 2018-19. So far, 318.919 million tonnes of net proved resources and 134.281 million tonnes gross indicated resources of coal have been estimated in this block, grade of which varies from G8 to G19. Exploration will continue in the area.

The Singareni Collieries Company Ltd. (SCCL)

During 2018-19, SCCL has explored the area to locate the presence of economic viable coal deposits and established its nature, shape and grade. An area of 11.50 sq. km was mapped in

Lingala-Koyagudem coal belt, Kothagudem coal belt, Anisettipalli-Monubothulagude, Sattupalli-Chintalapudi coal belt, Manuguru-Cherla coal belt, Ramagundem coal belt, Mulug coal belt, Dorli-Belampalli coal belt, Somagudem-Indaram coal belt and Kaghaznagar coal belt. A total of 326 exploratory boreholes were drilled to a cumulative depth of 99,544.0 m and total resources of 156.60 million tonnes were established thereby taking cumulative resource position at the end of 2018-19 to 10,622.32 million tonnes. The exploration work was carried out in the SCCL command area situated in Adilabad, Khammam, Karimnagar and Warangal districts of Telangana state.

CMPDI

During 2018-19, CMPDI continued its coal exploration activities mainly in CIL and Non-CIL/ Captive Mining Blocks. Exploration in CIL blocks was taken up to cater to the needs of 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 160 to 180 drills were deployed in 2018-19, out of which 71 drills were departmental drills.

CMPDI deployed its departmental resources for detailed exploration of CIL/Non-CIL blocks, whereas State Government of Odisha deployed resources in CIL blocks only. Besides, eleven other contractual agencies have also deployed resources for detailed drilling/exploration in CIL/ Non-CIL blocks.

In 2018-19, CMPDI and its contractual agencies took up exploratory drilling in 114 blocks/mines spread over 19 coalfields in seven states. Out of 114 blocks/mines, 35 were Non-CIL/Captive blocks and 79 CIL blocks/mines. Departmental drills of CMPDI were employed for exploratory drilling in 57 blocks/mines, whereas, contractual agencies undertook drilling in 57 blocks/mines. CMPDI extended its technical supervision in promotional/NMET exploration work undertaken by MECL in Coal Sector (CIL areas) in 15 blocks. On behalf of Ministry of Coal, DGM, Nagaland, has also carried out promotional exploration in one block and CMPDI in two coal blocks and a total of 1.39 lakh metres of promotional (regional) drilling was undertaken for coal and lignite during 2018-19 through, CMPDI.

A total of 13.60 lakh m of exploratory drilling have been carried out by CMPDI in 2018-19 of which deployment of departmental resources accounted for 5 lakh m while outsourcing involved 8.6 lakh m mainly from State Governments/MECL/Tendering (CIL/Non-CIL blocks). Details of exploratory drilling carried out by CMPDI in 2018-19 are given in Table - 4.

Lignite

GSI

The details of investigation for lignite during 2018-19 by GSI is given below:

In Tamil Nadu, G3 stage preliminary exploration for lignite was carried out in Kalari east sector, Ramnad Sub-basin, Ramanathapuram district. A total of ten boreholes have been completed since initiation of the work with cumulative drilling achievement of 5,414 meters. A total of 5 boreholes have been completed with total of 2,189 m drilling and 69 nos. of lignite samples for proximate analysis, 5 nos. of samples for trace element studies and 2 nos. samples for coal petrography studies were collected. The Quaternary and Cuddalore Formation contact in the area was intersected between depth range of 99 to 138 m. The Cuddalore/Tittacheri Formation and Neyveli Formation contact was intersected between depth range of 369 m and 453 m. The lignite seam was intersected between the depth range of 444 m and 534 m and the individual seam thickness varied from 1 to 22.40 m with cumulative thickness of lignite zone varying from 9.90 m to 23.75 m. Petrographic study of 2 lignite samples indicated higher content of Huminite Group of macerals (varying from 65.06%-72%). Inertinite & liptinite content of analysed samples varied from 3.65% to 11.80% & 1.83% to 2.43%, respectively. The quality of lignite in Ramnad sub-basin is comparable to the overall lignite quality of the Neyveli and Mannargudi Lignite Fields. The weighted recalculated calorific value & fixed carbon content varied from 1,486 to 3,510 Kcal/kg & 14.9 and 34.8 %, respectively. Calorific value of

most of the lignite samples (84 %) ranged between 2,000 Kcal/kg and 3000 Kcal/kg and belonged to Lignite – "B" grade. Of the samples collected 16% showed calorific value of less than 2000 Kcal/kg and are classified as Lignite–"C" grade. About 7 % of the samples belonged to Lignite –"A" grade as their calorific value was more than 3000 Kcal/kg. Lignite samples from BH TRKE-02 were analysed for REE and Ge. The analytical results of lignite samples from BH TRKE-02 showed that the total REE content ranged from 1.15 to 204.79 ppm and the Germanium (Ge) values varied from 0.10 to 6.2 ppm.

Table - 4: Exploratory Drilling by CMPDI (Departmental and Outsourcing) in 2018-19

Sl. No.	Agency	Target (lakh m)	Exploratory drilling achieved (lakh m)	Achieved (%)
1.	Departmental	4.80	5.00	104
2.	Outsourcing			
	i) State Govts.	0.01	0.02	200
	ii) MECL (MoU)	3.50	4.61	132
	iii) Tendering (CIL/Non-CIL Blocks)	5.36	3.97	74
Total		**13.67**	**13.60**	**99.49**

Directorate of Mines & Geology, Rajasthan

During 2018-19, exploration for lignite was continued n/v Diyatra, Tehsil Kolayat, Bikaner district. So far, 61 boreholes have been drilled to a cumulative depth of 11,153.50 m.The progressive average thickness of lignite was found to be 6.07 m. The progressive average of lignite/overburden ratio was 1:24.18. At the end of 2018-19, the total progressive lignite reserves estimated was at 28.33 million tonnes and that of carb clay was at 20.87 million tonnes. In Bikaner district, regional mineral survey near villages Gol Pratap ki Dhani in Nal Badi was continued with an objective to explore new lignite deposits in border region.

Neyveli Lignite Company India Ltd

During 2018-19, exploration for lignite in Palayamkottai and Veeranam block, Cuddalore district, Tamil Nadu was continued from previous field session through NMET scheme to bring the resources into Proved Category. In Palayamkottai block (32.00 sq. km area), 23 boreholes were drilled to a cumulative depth of 2,892.0 m and 236 samples were collected for chemical analysis. A total of 246.826 million tonnes of lignite resources were estimated under Measured Catergory. In Veeranam block (150.00 sq. km area), 80 boreholes were drilled to a cumulative depth of 20,319 m and 249 samples were collected for chemical analysis. The drilling continuing at 400 m grid interval.

In Rajasthan, promotional exploration funded by Ministry of Coal was taken up in Kheduli (140.0 sq.km) , Kuchera-Lunsara (110.0 sq.km), east of Gangardi & Ucgardi (440.0 sq.km) and Bansi (181.0 sq.km). In Kheduli block, 32 boreholes were drilled to a cumulative depth of 7,687.80 m and 61 samples were collected for chemical analysis. The estimation of resources is under progress. In Kuchera-Lunsara block, 51 boreholes were drilled to a cumulative depth of 8,726.00 m and 110 samples were collected for chemical analysis. The geological report is under finalisation. In east of Gangardi & Ucgardi block, 5 boreholes were drilled to a cumulative depth of 1,215.00 m and in Bansi block, 8 boreholes were drilled to a cumulative depth of 2,189.20 m and 23 samples were collected for chemical analysis. Lignite seams in all the four blocks have been intersected at moderate depths.

Non-ferrous Metals

Base Metals

GSI, MECL, HCL and HZL conducted investigations for copper, lead and zinc ores in different parts of the country during 2018-19.

GSI

The details of exploration activities carried out by GSI during 2018-19 are furnished in Table-5.

MECL

Exploration for copper, lead & zinc in Kusmarja and adjoining areas in Giridih district, Jharkhand was taken up with an objective to (i) identify various litho contacts lineaments/mineral-bearing areas, (ii) carry out geological mapping and demarcation of copper, lead & zinc-bearing host rocks, (iii) collect and analyse samples and (iv) to estimate resources. Remote sensing study was carried over an area of 100.00 sq. km and the area was mapped on 1:12500 scale. The total probable mineral target zones is four and extends to a spread of about 36.3 sq. km. The largest target zone named Zone-A is located at the north of Umri Kalan and covers about 13.2 sq. km and the 20 small zones named Zone-B located south of Mahoba Damron covers about 4.00 sq. km area. G4 level exploration in the area involved 40 nos of pitting of dimension 1 m x 1 m x 1 m and collection of 218 samples for analysis.

In Madhya Pradesh, a G4 level exploration for base metal and gold was taken up in Mohar Cauldron area, Shivpuri district. Exploration work comprised remote sensing study of 100 sq. km, geological mapping on 1:12500 scale and collection of 91 bedrock samples & 86 stream & soil samples. These samples were analysed for Cu, Pb, Zn, Au, Ag, REE, U, Mo and W. Analysis of bedrock samples showed Cu values ranging from < 1.0 ppm to 242.0 ppm, Pb values from 13.91 ppm to 41.14 ppm, Zn values from 10.17 ppm to 129.80 ppm, Au values with < 0.1 ppm, Ag values from <0.1 ppm to 0.3 ppm, U values from 1.42 ppm to 20.53 ppm and REE total values from 63.97 ppm to 359.34 ppm. Granite showed REE total values from 63.97 ppm to 359.34 ppm, andesite showed 114.09 ppm to 227.45 ppm and rhyyolite showed 129.78 ppm to 352.14 ppm. The result of NGCM of GSI and MECL indicate that the area seems to be of poor mineral potential at surface. Howerver, one grab sample from dug well dump showed Mo values of 281.0 ppm near Kanchanpur which indicates the possibility of a concealed molybdenum pocket at depth. Resources have not been estimated.

Hindustan Copper Ltd (HCL)

HCL has carried out various types of exploration in copper mines owned by it. Exploration in Malanjkhand copper mine, Balaghat district, Madhya Pradesh was carried out to find out the extent of ore body for dimension of stope and grade for underground mining. A total of 1,950.85 meterage were drilled in 10 boreholes. Resources estimated of the mine are placed at about 308.45 million tonnes with average grade of 0.92% Cu. In Jharkhand, exploration work was carried out in (i) Rakha mine where drilling of 15 boreholes to a cumulative depth of 2,796.00 m in Phase-I and 5,243.50 m in Phase-II was carried out; (ii) Surda mine where exploration work involved drilling of 2 boreholes to 1,576.00 m and shaft sinking of 168.00 m; (iii) In Kendadih mine the work involved 850.70 m drive & 984.60 m raise. The total resources of Rakha mine is placed at 123.52 million tonnes while at Surda mine it is 28.57 million tonnes and Kendadih mine 32.26 million tonnes. Exploration work in Jhunjhunu district, Rajasthan was carried out by HCL in (i) Kolihan mine, where drilling of 23 boreholes to a total depth of 2,166.10 m and collection of 5,270 samples were carried out; (ii) Khetri mine, where 5,279.85 meterage drilling in 52 boreholes and collection of 5,270 samples were carried out. Resources of copper were estimated at about 14.03 million tonnes at 1.34% Cu in Kolihan mine and 48.66 million tonnes at 1.43% Cu in Khetri mine.

Hindustan Zinc Ltd (HZL)

During 2018-19, HZL carried out about 100 km underground exploration and 60 km of surface exploration across all its properties. The total ore resources of all mines owned by HZL in the country stand at 403.00 million tonnes with 25.80 millions tonne of zinc metal, 8.90 million tonnes of lead metal and 964 million ounces of silver metal. The average metal content of zinc is about 6.86%, lead 2.2% and silver 77.66 g/t.

Zawar group of mines consist of four operating mines, i.e., Mochia, Balaria, Zawarmala and Baroi mines. A total of 1230 boreholes were drilled to a cumulative depth of 98,222 m and 45,812 samples for chemical analysis were collected from Zawar group of mines. The total gross reserves and resources (as on 01.04.2018) of Mochia, Balaria, Zawarmala, Baroi and Bara is placed at 105.835 million tonnes with average grade of Pb-2.29%, Zn-4.51% and Ag-43g/t.

Table - 5: Exploration for Base Metals by GSI, 2018-19

State/District	Name of block	Details of exploration	Results
Andhra Pradesh			
Nellore	Around Garimanipenta and Vinjamuru	Mapping, Drilling & Sampling	Reconnaissance survey (G4) for copper and associated mineralisation was taken up around Garimanipenta and Vinjamuru in the Nellore Greenstone belt. An area of 1.21 sq. km was mapped on 1:2,000 scale. The whole area is thick soil covered. A cumulative of 633.60 m of drilling were carried out in five scout boreholes in the area. Three boreholes have intersected a few disseminations of sulphides. The analysis of 46 core samples showed copper values up to 0.33%, 0.10% & 0.12% in boreholes APGPT-1/CS-1, 2 & 9 and 0.52%, 0.33%, 0.62%, 0.43%, 1.40% & 0.21% in boreholes APGPT-3/1, 5, 7, 8, 12 & 17 respectively. The exploration work was in continuation of the previous year's field study.
	Around Udayagir and Duttaluru	Mapping, Drilling & Sampling	During reconnaissance survey (G4) for copper and associated mineralisation, an area of 1 sq. km was mapped on 1:2,000 scale in two blocks, i.e., Masyapeta block (0.8 sq. km) and Tirumalapuram block (0.2 sq. km). Geophysical survey (IP and magnetic) of 20 lkm was also carried out. In Masayapeta block, incidence of sulphides (chalcopyrite, pyrite and covellite), malachite, and azurite staining were observed over a zone of 300 m length and 60-70 m width near old workings. A 200 m length and 20-30 m width zone of sulphide-bearing (chalcopyrite, pyrite, covellite, digenite) ferrugenised quartzite has been demarcated in Tirumalapuram block. Based on geophysical survey, high chargeability zone was observed in both Masayapeta and Tirumalapuram blocks. Trench mapping was carried out in the western part of Masayapeta block to trace the continuity of mineralisation. In analytical results, higher copper values have been reported in oxidised ferrugenised quartzite with sulphides, quartz vein & intercalated pelitic-psammitic sequence in both the blocks indicating incidence of copper and gold mineralisation. In Borehole APMAS-1, malachite staining was observed from 19.20 m to 23.30 m depth. Mineralisation was observed in the form of pockets and veins from depth 28.90 m to 76.30 m and 96.49 m to 111.49 m. Borehole APMAS-1 gave encouraging values of copper, 0.59% (30.3 m to 31.3 m), 0.54% (33.3 m to 34.3 m), and an average of 1.58% over 8 m length (43.3 m to 51.3 m) in Zone-I. Zone-II gave 0.46% (96.49 m to 97.49 m), 3.07% (100.49 m to 101.49 m) and 2.46% (105.49 m to 106.49 m). In APMAS-02, oxidised sulphides were noticed from depths 15.46 m to 16.00 m and 17.90 m to 19.50 m.
Arunachal Pradesh			
East Kameng	Pakke Kessang block	Mapping & Sampling	During preliminary exploration (G3) for copper and associated Au, Sn and W mineralisation in the metasedimentary sequence of Bomdila Group in Pakke Kessang Block, an area of 1 sq. km was

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Table - 5 (Contd)

State/District	Name of block	Details of exploration	Results
			mapped on 1:2000 scale. The mineralised zone was found to extend up to 1.5 km (approx.) in the study area. Within the metasedimentaries, pyrite, chalcopyrite, pyrrhotite and magnetite were observed. Stains of malachite were observed on the outcrop. Mineralisation occurs in form of veins, stringers, dissemination and sporadic cavity filling. Samples from quartz mica schist yielded up to 1.259 ppm Au and 0.9% Cu value and garnetiferous quartz mica schist yielded 1.013 ppm Au.
Himachal Pradesh			
Kullu	Naraul-Danala area	Mapping & Sampling	During preliminary exploration (G3) for copper, cobalt and nickel mineralisation in Naraul, Danala and Gobha areas, an area of 10 sq.km was mapped on 1:12,500 scale. Mineralisation observed was in the form of stains and encrustations of malachite, azurite and specks of chalcopyrite. In bedrock and channel samples, copper values ranged between 400 ppm and 0.40 %, cobalt between 10 ppm and 426 ppm and nickel values between 5 ppm and 124 ppm. The geophysical anomaly near old workings and already proved strike length (with wt. av. of Cu = 1.11 % Cu x 3.86 m and 180 m strike length) indicates that the area is promising for undertaking drilling as a total 500 m to 550 m strike length have been established.
Jammu & Kashmir			
Ganderbal	Sumbal-Kulan - Mamer areas	Mapping & Sampling	Reconnaissance survey (G4) for copper and associated mineralisation was carried out comprising mapping of 58 sq. km area on 1:12500 scale. Five important zones have been identified with abundance of sulphides. These include surface mineralisation zones near Bazan Nar, Purnibal and three new reportings at Saedbasti, Gund and Sur Phraonala. The pyrite is the most abundant sulphide mineral in the area followed by chalcopyrite, pyrrhotite, bornite and covelite. A total of 172 samples were collected for base metal and Au & associated elemental analysis for 86 samples have been received. A few BRS and PTS showed higher values for Cu (> 1900-4095 ppm, n=4), Co (543 ppm, n=1) & Pb (1918 ppm, n=1 from trench sample).
Baramulla	Darakanjan & Bela Salamabad, Uri area	Mapping & Sampling	Reconnaissance survey (G4) was carried out with an objective to delineate mineral prospective zones for base metal. The mineralisation in the area is mainly confined along the eastern slopes of Hapathkhai Valley spread over a stretch of about 6 km from Batangi-Barnet to Darakunjan. The mineralisation comprised galena, sphalerite, chalcopyrite and pyrite. The occurrence of galena mineralisation is observed as specks, stringers and veins. Limonitised/ ferrugenised zone containing sulphide mineralisation has also observed. Two sets of quartz veins carry sulphide mineralisation in the form of detached and discontinuous veins; The length of individual quartz vein varied from 0.2 cm to 15 cm. Besides, old workings have also been observed at Banali, Darakujan, Narkasi and Dudhran.

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Table - 5 (Contd)

State/District	Name of block	Details of exploration	Results
Karnataka			
Raichur	Machanur block, Lingasugur Taluk	Mapping, Drilling & Sampling	Preliminary exploration (G3) for delineation of copper and REE mineralisation in the area was initiated in field session 2017-18. In total, 4 sq. km area has been covered with mapping on 1:2,000 scale and 1616 m drilling in 8 boreholes (six first-level and two second-level). The mineralised zone in Machanur area is found to occur up to 4 km in length with width of about 50-150 m. The average thickness of the ore zone is 48 m with a strike length of 700 m. Chalcopyrite is the main ore of copper in the area followed by bornite, covelite, and native copper. Analytical results of Borehole KRM-01 showed four mineralised zone with true thickness of 8 m x 0.13% Cu, 17 m x 0.15%, 2.37 m x 0.14%, 9.0 m x 0.10% Cu at 0.1% cut-off; Borehole KRM-02 showed two mineralized zone 3.68 m x 0.35% and 57.76 m x 0.25% Cu. The borehole intersected two anomalous zones of gold of 3.5 m x 89 ppb and 3 m x 94 ppb Au; KRM 04, a second-level borehole intersected two zones, viz. 3.08 m x 0.10% Cu and 59.96 m x 0.61 % Cu at 0.1 % cutoff. The Borehole KRM 05 has intersected highly disseminated copper mineralisation therefore only a small zone with true thickness of 2.2 m x 0.1 % Cu and an anomalous Au zone, i.e., 2.7 m x 81 ppb Au were observed; KRM 06 has intersected a relatively high grade zone with 8.7 m x 0.86% Cu along with Au of 6.8 m x 287 ppb Au. KRM-07 has also intersected a feeble mineralised zone of 2.68m x 0.18% & 4.5 m x 127 ppb Au. Another second-level borehole (KRM-8) has also intersected highly disseminated sulphides. The area was also covered with magnetic, IP and resistivity surveys to a total of 36 L km. Based on the available analytical results of borehole core samples, a total resource of 10.45 million tonnes with 0.39% Cu at 0.1% Cu cut-off grade have been estimated. The investigation in Machanur copper is carried out under G-3 category and resources has been estimated under 333 category of UNFC.
	Gurgunta / Parampur Schist Belt	Mapping	During reconnaissance survey (G4) for evaluation of copper and REE, Rare Metal mineralisation in the area, a total of 100 sq. km area was covered on 1:12,500 scale mapping. Two hydrothermal alteration zones were identified and mapped; one near Aidabhavi and other fault-controlled alteration zone was observed around Village Phulbhavi , where the N-S trending fault show brecciation and silicification. The quartz veins also show chloritisation, K-feldspar alteration and haematite-alteration.
Chitradurga	In and around Nerlakere, Maddakere, Gollarahalli, Kanchipura areas,	Mapping Sampling	Reconnaissance survey (G4) for multimetallic mineralisation in the area involved mapping of 124 sq. km on 1:12,500 scale. The SEM-EDS study revealed the presence of sulphides in the form of pyrite, chalcopyrite, arsenopyrite, pyrrhotite, galena and spalerite in BIF and quartz. Micrograins of Au (<4 µm) mainly associated with chalcopyrite were also observed in the exposed lithounits. Analytical results of BRS samples indicated that the Au, Ni and

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Table - 5 (Contd)

State/District	Name of block	Details of exploration	Results
			Zn values ranged up 30 to 30 ppb, 10 to 110 ppm and 75 to 150 ppm respectively. Stream sediment samples showed a maximum value for Zn, Ni & Co of 150 ppm, 130 ppm and 70 ppm respectively. Similarly, 15 soil samples showed Cu and Ni values ranging from 10 to 75 ppm and 15 to 180 ppm respectively.
Madhya Pradesh			
Betul	SW part of Banskhapa-Pipariya Sub block-I	Drilling & Sampling	G-2 stage exploration over a strike length of 550 m was taken up to assess the base metal mineralisation in South Western part of Banskhapa-Pipariya Sub-block-I. A total cumulative drilling of 1,416.05 m were done in 10 boreholes to check the depth persistence of mineralisation. Semi-massive to massive sphalerite ore with chalcopyrite and pyrite have been found to occur within the garnetiferous biotite-anthophyllite granite schists. The disseminated mineralisation is manifested in the form of of sphalerite, chalcopyrite, pyrite and a few pyrrhotite. Based on the analytical data of the boreholes, presence of mineralisation was established at vertical depth of 50 m, 100 m & 150 m over a strike length of 550 m with maximum values of 3.98% for Zn & 1.56% for Cu in Boreholes MPBBP-08 and MPBBP-01 respectively with consideration of minimum stoping width of 2.0 m.
Maharashtra			
Bhandara	In and around Wadegaon area	Mapping, Pitting/Trenching & Sampling	Reconnaissance survey (G4) for copper and associated base metal mineralisation involved Large-Scale Mapping of 100 sq. km area and detailed mapping (1:2000 scale) of 1 sq. km around SE of Village Dongargaon and SE of Village Mendha. Some quartz veins are the locales for base metal mineralisation. The smoky variety quartz veins of thickness 5 cm to 1 m were observed to be prominently mineralised. Specks of chalcopyrite, pyrite, magnetite, sphalerite grains within smoky quartz were found to be present. Occurrence of sulphide mineralisation also was observed in the phyllites of Gaikhuri Formation. A total of 50 pit/ trench samples were collected from the gap area between the smoky quartz veins. Chemical analysis of bedrock samples showed copper values ranging from >10 ppm to 0.81%; lead values ranged from >10 ppm to 290 ppm; zinc values ranged from >10 ppm to 225 ppm and gold values ranged from >25 ppb to 1090 ppb.
	Machanur block		
Mapping		Drilling & Sampling	
Chandrapur	Chikmara - Tambegadi Mendha area	-	Reconnaissance survey (G4) stage investigation was carried out with an objective to identify copper and associated mineralisation around the study areas. The main host rock for copper mineralisation in the explored area is ferruginised gneisses and copper mineralisation was found to occur within numerous secondary ferruginous veins. Two zones (One 700 m and other 300 m) were identified as potential zone for geophysical investigation. At Pathari, surface manifestation of copper is in the form of malachite veins emplaced along the gneisses. The host rock here is gneiss and BMQ.

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Table - 5 (Contd)

State/District	Name of block	Details of exploration	Results
Odisha			
Deogarh	Adash block	Trenching & Sampling	General exploration (G2) was carried out with an objective to evaluate the depth potential and grade of copper and associated mineralisation and to delineate graphite zone in Adash block. Surface manifestations of base metal mineralisation are in the form of malachite staining and oxidation. A total of 100 cu. m of trenching were carried out along the profile of the proposed and already drilled boreholes. Average thickness of the lode in the Trench was 12.0 m with average grade of 0.63% Cu. Average thickness of the lode in Trench-II was 11.0 m with an avaerage grade of 0.51% Cu. The Au value in both the trenches varied from 0.05 ppm to 0.34 ppm. A total of 602.20 m of drilling were carried out in 4 boreholes. Base metal mineralisation in one borehole was intersected from a depth of 56.00 m in the form of minor disseminations, specks and fracture filling of pyrite, chalcopyrite and pyrrhotite. However, richer dissemination occurs at a depth of 81.00 to 108.00 m. In another borehole, mineralisation was intersected from a depth of 49.00 m in the form of minor disseminations, but richer dissemination appeared at depths from> 75.00 m to 95.00 m.
Mayurbhanj	Madansahi block	Mapping & Sampling	Preliminary exploration (G3) for copper and associated precious metals involved mapping of 1.50 sq. km area on 1:2000 scale and 2,026.50 m drilling in 13 boreholes. The block is located in the eastern fringe of the Singbhum shear zone. Surface evidences of mineralisation were marked by the presence of malachite azurite stains and occasional fine specks and disseminations of pyrite and chalcopyrite. The main sulphide minerals were pyrite, chalcopyrite and phyrrohtite with association of little nickel and magnetite. Based on the borehole intersections, sulphide mineralisation zone of 1.2 km strike length has been established with cumulative thickness that varied from 15 m to 35 m. Part analytical results of bedrock samples showed copper value varying from 10 ppm to 9,100 ppm. Part assay value of borehole core samples showed copper values up to 8.30% Cu.
Rajasthan			
Banswara	Jharka block, southeast of Mahuwal	Mapping, Trenching & Sampling	Preliminary exploration (G3) for base metal and associated gold mineralisation has been carried out to assess the nature and potentiality of gold and base metal mineralisation. Detailed geological mapping covering 1.7 sq. km area on 1:1,000 scale in Jharka block was carried out. The exploration work comprised a total of 75 cu. m trenching along with 75 samples being collected from 9 trenches. Surface indications of mineralisation in Jharka block were found to be manifested in the form of malachite stains and presence of fresh sulphides like chalcopyrite and pyrrhotite within the quartzite and dolomite, oxidisation/ferruginisation and old working/ pits. On the basis of surface indication of mineralisation, a promising mineralised zone has been delineated on the surface. A total of 130 m of

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State/District	Name of block	Details of exploration	Results
			drilling were carried out and sulphide mineralisation was intersected in quartzite in the form of pyrite and chalcopyrite from 22.5 m to 22.7 m depth. The drilling was suspended due to presence of lean mineralisation.
Banswara	Tartai block, NW of Mahuwal	Mapping, Drilling, Trenching & Sampling	Preliminary exploration (G3) was carried out with the objective to assess potentiality of base metal and gold mineralisation in Tartai block. Exploration work comprised detailed mapping of 1.5 sq. km on 1:1,000 scale along with collection of trench samples for gold-copper assay. A thorough geological study in the block inferred that there are no significant surface evidences of mineralisation except one quartz vein with feeble malachite stains. Drilling has been suspended after completion of 252 m in two boreholes. One borehole was drilled up to 142 m. Rare specks of chalcopyrite have been observed at the depth of 87 m. Similarly, no evidence of mineralisation has been recorded in the other borehole also. A total of 58 bedrock samples were analysed and the results of quartz vein samples indicated copper values ranging from 5 ppm to 20 ppm, cobalt values from <15 to 20 ppm, nickel from <15 to 40 ppm, lead near 25 ppm, zinc from <5 to 10 ppm and gold and silver values close to <0.05 ppm and 5 ppm respectively, whereas in schist samples, copper values ranged from 5 ppm to 470 ppm, cobalt values from <15 to 120 ppm, nickel from <15 to 60 ppm, lead from <15 to 45 ppm and zinc from <10 to 85 ppm. Gold and silver values were <0.05 ppm and 5 ppm respectively. Analysis of about 79 trench samples revealed that in quartz vein samples, copper values ranged from 5 ppm to 3,900 ppm, cobalt values from <15 to 85 ppm, nickel from <15 to 80 ppm, lead <25 ppm, zinc from 5 to 105 ppm and gold from <0.05 to 0.65 ppm. The high value of copper up to 3,900 ppm and Au from <0.05 to 0.65 ppm were observed in samples from Trench no.3. The high values are probably due to the presence of slag.
Jhunjhunu	Bokri north and its north-eastern continuity	Drilling	During general exploration (G2) for copper and associated mineralisation in Bokri north and its north-eastern continuity, Eastern Khetri Metallotect, a total of 3,446.95 m drilling were carried out in 19 boreholes. The objective of the study is to prove subsurface continuity of copper and associated mineralisation by 5,000 m drilling in 23 boreholes and estimation of resource. Intersected mineralisation was found to be manifested in the form of dissemination, streaks and as veins & fracture filling of chalcopyrite, pyrite, and rarely pyrrhotite and magnetite. A total of 15 boreholes intersected copper mineralisation with varying thickness and grade of copper. The intersected thickness along boreholes ranged from 2.0 m to 43.75 m with a VE of 0.2 to 0.25 % Cu. The study is likely to be continued in field season of 2019-20.

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State/District	Name of block	Details of exploration	Results
Rajasthan			
Jhunjhunu	North-east continuity of Malwali block	Drilling	A total of 1,096 m drilling were carried out at 6 boreholes to intersect mineralisation at 60 m vertical depth in the north-eastern continuity of Malwali block. In the boreholes RJMN-1, 2 and 3, three mineralised zones of 5 m to 40 m thickness were intersected. In boreholes RJMN-4 and 5, mineralisation splits into five zones of 5 m to 18 m thickness. In Borehole RJMN-6, two mineralised zones of 5 m to 13 m thickness were intersected. The area lies in the south-eastern parts of North Khetri Belt. Copper mineralisation is evidenced by presence of malachite staining, old workings and old prospecting. The copper ore resource will be estimated after receipt of core samples analytical results.
Sikar	Khora extension block, Nim ka Thana	Drilling	The surface evidences of mineralisation are widespread, intense and pervasive malachite stains. Occurrences of chalcocite and bornite as dissemination and vein filling have also been recorded. In subsurface, the mineralisation occurs in the form of fine specks of chalcocite, bornite and covellite as dissemination which is mostly concentrated in calcite/quartz-rich zones. A total of 20 boreholes that have been drilled intersected copper mineralisation mainly in the form of chalcocite, bornite and chalcopyrite. Study will continue in field season 2019-20.
Sikar	Bhudoli block, Nim ka Thana	Mapping	Preliminary exploration (G3) includes detailed mapping of 1.0 sq. km area (1:2,000 scale). Surface evidence of mineralisation was found to be manifested in the form of sporadic malachite staining in calc-silicate. Fresh sulphides observed are of rare occurrence.
Pali	Phulad-Saran-Kantaliya area	Mapping	During reconnaissance survey (G4) for base metals and gold mineralisation, a total of 100 sq. km area were mapped on 1:12,500 scale. Pyrite, pyrrhotite, chalcopyrite within the calc-silicate and amphibolite have been observed at places.
Alwar	Mundiyawas block Mundiyawas -Khera area	Drilling & Sampling	During G2 level general exploration for copper and associated precious metals in Mundiyawas block, Mundiyawas-Khera area, 15 boreholes were drilled to a cumulative depth of 2,798.40 m. All the boreholes intersected significant copper mineralisation. The dominant ore minerals were chalcopyrite, pyrrhotite and arsenopyrite. The mineralisation occurred in the form of disseminations, streaks, stringers, vein and fracture fillings and occasionally massive type. Part analytical results showed that the Borehole No-21 intersected copper lode of 6.2 m thickness with 0.40% Cu and Borehole No-26 intersected two copper lodes of 4.05 m cumulative thickness with 0.20% Cu at 0.2% Cu cut off. The Borehole No-27 intersected two copper lodes of cumulative thickness 18.4 m with 0.54% Cu at 0.2% Cu cut off and one gold lode of 2.6 m thickness with 0.79 g/t Au at 0.5 g/t Au cut off. The exploration work will continue in field season 2019-20.

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State/District	Name of block	Details of exploration	Results
Alwar	Khera North block, Mundiyawas-Khera area	Drilling & Sampling	During G3 level preliminary exploration for base metals and associated precious metals in Khera north block, Mundiyawas-Khera area, a total of 1,007.80 m of drilling, 998.42 m geophysical borehole logging and 3.52 L km Mise-a-la-Masse were carried out and 380 core samples were collected and analysed to delineate the zones of copper and associated precious metals mineralisation. A sulphide zone of 150 to 200 m strike length has been delineated in this block. Major mineralisation was intersected in the form of specks, stringers, fracture filling and massive chalcopyrite associated with pyrrhotite and minor arsenopyrite and pyrite.
	Jhiri block, Pratapgarh, Thanagazi tehsil	Mapping, Drilling Pitting/Trenching & Sampling	G3 level of preliminary exploration for base metals and associated precious metals in Jhiri block, Pratapgarh, Thanagazi tehsil comprised detailed mapping of an area of 1.5 sq. km on 1:2000 scale, 15 L km geophysical survey and 100 cu.m of pitting and trenching. A total of 6 boreholes were drilled to a cumulative depth of 802 m with 200 m spacing and the major sulphide phases noticed in the study area have been that of pyrite and pyrrhotite. The exploration work is in progress.
	Bisoni block, Thanagazi tehsil	Drilling, Pitting/Trenching & Sampling	G3 level of preliminary exploration for copper and associated precious metals in Bisoni block, Thanagazi tehsil involved 853.85 m drilling in 5 boreholes, pitting/trenching of 62 cu. m and collection of 175 core samples & 50 pit/trench samples. The boreholes intersected sulphide mineralisation in the form of specks, stringers of bornite and covellite, Pyrite and pyrrhotite are noticed in abundance and arsenopyrite, galena & hessite (Te and Au) were also seen. The exploration work is in progress.
	Angari block, Thanagazi tehsil	Drilling & Sampling	During preliminary exploration (G3) for copper and associated precious metals in Angari block, Thanagazi tehsil, a total of 1,226 m drilling in 8 boreholes with depth ranging from 120 m to 240 m were carried out in the central and western parts of the Angari block. Three boreholes intersected sulphide mineralisation in the form of specks, stringers, vein filling and occasional massive bornite, chalcocite and chalcopyrite within tremolite- bearing dolomitic marble and quartz vein. A total of 300 core samples have been collected for chemical analysis.
	Pai ka Guwara block, Tehla-Bighota area, Rajgarh Tehsil	Drilling, Pitting/Trenching & Sampling	During G3 stage preliminary exploration for base metals and associated precious metals in Pai ka Guwara block, Tehla-Bighota area, Rajgarh Tehsil, a total of 1,265.95 m of drilling were carried out in 8 nos. of first and one 2nd level borehole. About 125 bedrock samples and 595 channel/trench samples were analysed to establish the mineralised zones. On the basis of analytical results and surface indication of copper mineralisation, two mineralised zones were established. The first mineralised Zone-I was delineated in white siliceous dolomitic marble. The mineralised Zone-II was delineated in carbonaceous phyllite and it extended for a strike length of 200 m

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State/District	Name of block	Details of exploration	Results
			with width of 15 m. A total of 595 core samples were collected for analysis. The mineralised zone has a lensoid shape and copper mineralisation was found to occur mainly in the form of chalcopyrite, chalcocite and bornite.
Alwar	Ramsinghpura block, Tehla-Bighota area, Rajgarh Tehsil	Mapping, Drilling, Pitting/Trenching & Sampling	Preliminary exploration (G3) for base metals and associated precious metals involved a total of 767 m of drilling in Ramsinghpura Block, Tehla-Bighota area, Rajgarh Tehsil along with detailed mapping of 1.0 sq. km area on 1:2000 scale. On the basis of presence of malachite staining and fresh sulphides, a mineralised zone of 400 m strike length with a width of about 25-50 m has been delineated on the surface. A total of 135 channel samples were analysed for base metal. During field session 2018-19, 5 first level boreholes were drilled to establish the depth persistence and strike continuity of the mineralised zone in the area. Sulphide mineralisation has been intersected in these boreholes mainly in the form of fine disseminations and rare specks of pyrite, chalcopyrite and malachite stains. It has intersected only pyrite-bearing carbonaceous rocks of Thanagazi Formation. The exploration work will continue in field season 2019-20.
	Jodhawas-Kishori block,	Mapping, Pitting/Trenching & Sampling	During G4 stage reconnaissance survey for base metals in Jodhawas-Kishori block, an area of 100 sq. km was mapped on 1:12,500 scale. During Large-Scale Mapping, 5 trenches were laid in NE of village Ganeshpura to check the continuity of mineralisation. A total of 48 cu. m trenching and 2 cu. m of pitting were carried out along with collection of a total of 50 samples. The area showed evidences of mineralisation and mining activity in the form of old working, ferruginisation, brecciation and occasional occurrences of malachite staining. Old workings point towards ancient smelting activities undertaken for winning copper in the area. In the NW of Raipura area near Village Kishori, a 50 m wide zone of silicification was noticed which was marked by quartz veins of 10 to 15 cm width. Fresh sulphides like chalcocite and bornite are suspected in these quartz veins. Both limonitic stains and malachite stains are also noted in the quartz veins. On the basis of these evidences, different mineralised zones were delineated in the area. The exploration will continue in field season 2019-20.
Sikar	Northern part of Toda-Ramliyas block	Drilling	During general exploration (G2) for base metal mineralisation in northern part of Toda-Ramliyas block, a total of 3,714.50 m drilling in 16 boreholes were carried out. On the basis of visual estimation, the Cu mineralised zone was observed to extend to a strike length of over 800 m and 250 m vertical depth. On the basis of subsurface data, it can be inferred that the copper mineralisation becomes shallower towards the northern part of the block. The study will continue in field season 2019-20.

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State/District	Name of block	Details of exploration	Results
Sikar	Nathuwala block	Drilling Trenching & Sampling	During preliminary exploration (G3) for base metal and associated precious metals mineralisation in Nathuwala block, a total of 1,205.30 m drilling were carried out in 9 first-level boreholes along with 50 cu. m of trenching. Mineralisation is present as veins and fracture filling. The main sulphide minerals observed in the mineralised zone are pyrite, chalcopyrite, pyrrhotite, chalcocite, bornite and covellite associated with quartz and carbonate veins. The mineralised zone extends for a strike length of over 1.8 km. Petrographic studies of the core samples confirmed the presence of chalcocite and bornite as the main ore minerals of copper along with chalcopyrite, pyrrhotite, sphalerite, galena and pyrite. One borehole intersected a zone of more than 45 m thick sulphide mineralisation which included 21.0 m of Cu lode with Cu ranging from 0.20% to 0.34%. Another borehole intersected a zone of more than 54 m thick sulphide mineralisation. It included a copper lode of 9.0 m thickness with Cu ranging from 0.35% to 0.51%.
	South Ghatiwala block	Drilling	During preliminary exploration (G3) for copper in South Ghatiwala block, a total of 996.15 m drilling were carried out involving 6 boreholes. The boreholes intersected feeble and sporadic copper sulphide mineralisation in the form of fine disseminations, vein filled, specks and fracture filled smears of bornite, chalcocite and very few specks of chalcopyrite and covellite. Vein filled specks of specularite and fracture filled and disseminated pyrite also have been observed in the boreholes. Borehole No-2 & 03 intersected copper mineralisation with a thickness of 03 m x 0.14% Cu and 01 m x 0.2% Cu and 01 m x 0.1% Cu, respectively while Borehole No-01 did not intersect any significant copper mineralisation. The study will continue in field season 2019-20.
	Narda-Kalakota block	Mapping & Sampling	Reconnaissance survey (G4) for base metal and associated precious metal was taken up with mapping of 60 sq. km area on 1:12,500 scale along with collection of random/grid bedrock, PCS, channel and trench samples. Surface indications of copper mineralisation were observed in three major areas such as Daudham, west of Narda and NW of Sanja Ki Dhani. The surface evidences of copper mineralisation included malachite stains and presence of fresh sulphides, such as, bornite and chalcopyrite. The ore petrographic study confirmed the presence of copper mineralisation in the form of vein filled and disseminated grains of chalcopyrite. Covellite and pyrite association and bornite, covellite & chalcopyrite association were observed in NW of Sanja Ki Dhani.

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State/District	Name of block	Details of exploration	Results
Bhilwara	Lanpiya-Indrapura area,	Mapping, Pitting/ Trenching & Sampling	During reconnaissance survey (G4) for copper and associated mineralisation in Lanpiya-Indrapura area (between already explored Banera and Sanganer block), Large-Scale Mapping of 100 sq. km area on 1:12500 scale was carried out along with 106 cu. m of pitting/trenching. Besides, 30 ground water samples were collected from closed ground water system to trace the presence of subsurface mineralisation in the soil/alluvium covered area. Surface manifestations of base metal mineralisation are quite prominent in the area. Malachite staining has been observed in almost all the litho-units of the area. Specks and veins of primary sulphides like chalcopyrite, bornite, pyrrhotite and pyrite were observed in the BMQ. Several oxidised and gossanised zones have been noticed in the area of Arjiya, Devpura, and Zeepiya & Ranikpura. Old working, slag heaps, mine dumps with malachite stains and recent mine shafts have been observed in Ranikpura, Devpura, and Pola Ji Ki Dungar areas.
Chittaugarh	Rewara Prospect, Pur-Banera belt	Mapping, Drilling & Sampling	Preliminary exploration (G3) for base metal mineralisation was taken up with an objective to reassess the subsurface Pb-Cu-Zn mineralisation in already explored Rewara Prospect. The exploration work comprised drilling to a total depth of 1,570 m in 8 boreholes, detailed geological mapping of 1.00 sq. km area on 1:2000 scale and collection of 570 core samples. Surface manifestations of mineralisation are observed in the form of old workings, vertical shafts and slag dumps. The mineralization is lithologically and structurally controlled. The mineralisation intersected in boreholes is in the form of stringers, thin veins, specks and disseminations of chalcopyrite, galena, sphalerite and pyrite. The thickness of the zones intersected in the boreholes varied from 2.0 to 5.50 m and comprised visual estimates of Cu (0.1 – 0.5%), Pb (0.5 – 2.5%) and Zn (0.3 – 0.7%) approximately. The study will continue in field season 2019-20.
Udaipur	Lalpura, Bemla & Ramaj area	Mapping & Sampling	During reconnaissance survey (G4) for copper and associated mineralisation in Lalpura, Bemla and Ramaj areas, Large-Scale Mapping of 100 sq. km area on 1: 12,500 scale was carried out. Surface manifestations of copper mineralisation were observed in the SW and NE parts of the study area in the form of profuse malachite staining, extensive ferruginisation, limonitisation and gossan zones. Specks and stringers of chalcopyrite, covellite and pyrite have been noticed within the ferruginous and micaceous quartzites near Bajani Rori-Bemla-Rupatalai-Budal-Lalpura areas. The mineralisation is lithologically as well as structurally controlled. The chemical data of 60 bedrock samples showed anomalous Cu values ranging from 0.11% to 2.07% with an average Cu value of 0.55%. The study will continue in field season 2019-20.

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State/District	Name of block	Details of exploration	Results
Bhilwara	Kamalpura NE block	Drilling & Sampling	Under G2 exploration, general exploration for copper in Kamalpura NE block and reassessment of earlier explored Kamalpura block in Southern Part were executed in Kamalpura block with the objective to assess copper ore resource. The G2 stage drilling of 6,550 m was carried out in 20 boreholes and a total of 2,200 core samples were collected. Boreholes at a general strike spacing of 100 m have been drilled to assess the strike as well as down dip continuity of the copper mineralised zones. Since, 2013-14, a total of 10,235 m drilling were carried out in Kamalpura Block in 38 boreholes. During 2018-19, a total of 20 boreholes were drilled. Chalcopyrite is the main copper ore mineral identified in the core samples. Other sulphide minerals present are pyrite, pyrrhotite, bornite and arsenopyrite occurring as disseminations, stringers and sometimes as thin films along foliation, bedding planes and fractures. The expected copper mineralised zones in terms of thickness and grade were intersected in all the drilled boreholes varying in grade from 0.20 to 3% Cu. The visually estimated copper mineralised zones ranged from two zones to seven zones in the boreholes. The positive outcome from the boreholes drilled for first level, 2nd and third level will add a very significant increase in tonnage in the tune of doubling of the present copper resource to be calculated for the vertical depth of 180 m. Item continued as spillover in FS 2019-20.
	Sopura-Sethuria area	Mapping & Sampling	During reconnaissance survey (G4) for base metal in Sopura-Sethuria area, an area of 100 sq. km was mapped on 1:12,500 scale. Intense malachite staining was noticed in quartzite hill, north of Village Sethuria for length of 1.8 km and width of 300 m. Fresh sulphide minerals like chalcopyrite, covellite, bornite and pyrite with profuse malachite stains were reported in calc-silicate rock in well dump near Village Hirakhedi. An area of 1 km x 0.5 km was recommended for further investigation. Geochemical samples have been submitted for analysis.
	South west of Agucha	Mapping & Geophysical survey & Drilling	Reconnaissance survey (G4) for Pb and Zn mineralisation comprised 350 sq. km ASTER image processing, 50 sq. km area of large scale mapping (1:12,500), 0.75 sq. km area of detailed mapping (1:2,000), 590 m of scout drilling in 3 boreholes, 16 L km ground geophysical survey (SP, IP, Magnetic) and 590 m of Mise-a-la-masse survey. Malachite stains were noticed in dump materials of dug well near Parsarampura (west of Agucha).
Alwar	Deota area	Drilling & Sampling	Preliminary exploration (G3) for basemetal and associated precious metal was carried out in the Deota area. A total of 302.80 m of drilling in two boreholes were carried out and 29 core samples, 10 petrography samples and 10 ore petrography samples were collected to study the nature of mineralisation. The boreholes did not intersect any mineralisation as the surface mineralised zone showed no strike and depth continuity.

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State/District	Name of block	Details of exploration	Results
Bhilwara	Urja Ka Khera area	Mapping	Preliminary exploration (G3) was taken up with the objective to evaluate potentiality of Pb, Zn and associated mineralisation in Urja Ka Khera area, south of Agucha deposit. Detailed mapping covering 2.00 sq. km area on 1:2,000 scale was carried out in Urja Ka Khera and Barantia villages. As most of the area was observed to be soil covered, the surface indications for mineralisation are distinctly seen in the Urja Ka Khera block. Only persistent gossan, ferruginisation and limonitisation are present with malachite staining along the weak planes on calc-silicate rock. Yellow to orange coloured ferruginised material were seen in the dump of dug wells found near Village Urja Ka Khera. The study will continue in the next field season 2019-20.
Uttarakhand			
Rudraprayag	Kund-Bamsu area	Mapping	During reconnaissance survey (G4) for copper and associated mineralisation in Kund-Bamsu area, a total of 50 sq. km area were mapped on 1:12,500 scale. Sulphide mineralisation observed near Village Bamsu occurred as specks and disseminations of chalcopyrite, bornite, pyrite within chlorite schist, gneisses and quartz-sericite schists. Malachite and azurite staining were also found in the vicinity. The oxidised zone is sporadic in nature and occurred as pockets at different locations around Dayuli-Bamsu villages and lacked significant exposure due to cultivation. At places, the oxidised zone appeared to be brecciated. Minor sulphide mineralisation was also found around Semla-Dungar areas and Sursal area.
Uttar Pradesh			
Mahoba	Bundelkhand Granitoid Complex	Mapping & Geophysical survey	During reconnaissance survey (G4) for sulphide mineralisation in Bundelkhand Granitoid Complex, large scale mapping on 1: 12,500 scale was carried out for 104 sq.km along with geophysical survey (IP, SP, Magnetic) of 51 L km. The investigation was taken up with an objective to assess the potentiality of base metal mineralisation in the Bundelkhand Granitoid Complex. Specks, disseminations and smears of pyrite, pyrrhotite and chalcopyrite were observed in quartz reef and medium-grained pink granite occasionally. Geophysical surveys viz. IP, SP and Magnetic were conducted south-west of Mahoba in two blocks. Preliminary analysis of IP, Resistivity and Magnetic data does not reveal any prominent geophysical anomaly zones in the area.

Bauxite

GSI

In Gujarat, reconnaissance survey for lateritic bauxite, clay and possible REE mineralisation around east of Umarsar, Lakhpat taluka, Kachchh district involved large scale mapping of 50 sq. km area on 1:12,500 scale, detailed mapping of 3 sq. km area on 1:4,000 scale around Dharesi, Akri, Umarsar and Chugger villages along with pitting/trenching of 100 cu.m and collection of BRS, PTS and XRD, PS/OS samples. Detailed mapping was carried out in 3 blocks around Dharesi, Akri, Umarsar and Chugger villages. The strike continuity, width and thickness of the laterite/bauxite in the area varied from 1.8 to 4.3 km, 0.8 to 255 m and 0.5 to 5.5 m, respectively. Pisolitic structures have been observed in bauxite of Dharesi block.

A reconnaissance survey for lateritic bauxite and clay was carried out around Asambiya Nana, Mandvi taluka, Kachchh district. The investigation involved detailed mapping of 5.9 sq. km area on 1:4,000 scale. The bauxite/lateritic bauxite band was found to extend for a strike length of 3.7 km with width varying from 160 m to 700 m. The cumulative thickness of primary and secondary bauxite varied from 1 m to 18 m. EPMA study showed that the clast/framework grains of bauxite were enriched with Al_2O_3 (up to 87%) while matrix part was enriched in FeO (up to 81%). TiO_2 was also found to be associated with the clasts/oolitic grains. Out of the 55 samples, ICPMS results of one sample showed values of La -1867 ppm, Ce-1039 ppm and Pr-425 ppm.

In Jharkhand, a G3 stage preliminary exploration for bauxite and associated minerals (Ti,V, Ga, etc.) with bauxite and red clay in Pokripattoli area, Serangdag plateau, Gumla and Lohardaga districts was carried out which included detailed mapping of 5 sq. km area on 1:4,000 scale and 1,518.2 m of drilling in 32 boreholes. The lithounits of the mapped area consisted of lateritic soil, laterite, bauxite, variegated clay and granite gneiss. Bauxite/ lateritic bauxite was intersected in all the boreholes with thickness ranging from 0.28 m to 8.2 m. However, bauxite thickness > 1 m was recorded in 29 boreholes and towards east the thickness of the bauxite horizon was found to be decreasing whereas the thickness of the bauxite/ lateritic bauxite horizon showed an increasing trend southwards. The red clay intersected in the boreholes showed thickness varying from 1.50 m to 8.85 m. Variegated clay below the bauxite horizon is observed as white to pinkish white, light cream, yellow coloured as well as showing purple, brown, white & grey colour.

In Meghalaya, reconnaissance survey for lateritic bauxite and associated minerals was conitued from field session 2017-18 in the eastern part of Umsung area, West Khasi Hills district. An area of 1.5 sq.km was mapped on 1:4,000 scale. Chemical analysis of bedrock samples showed that the bauxite ore was composed of Al_2O_3 (30.99% to 67.15%, average. 50.61%), Fe_2O_3(T) (3.65% to 37.81%, average 16.71%), SiO_2 (0.1% to 45.51%, average 10.18%) and TiO_2 (0.76% to 8.07, average 3.30%). In addition, gallium (Ga) values in the range of 36 ppm to 113 ppm with an average of 79.38 ppm and vanadium (V) values from 89 ppm to 1,432 ppm with an average of 429.52 ppm were recorded in the bauxites. The exploration work will continue in next field season 2019-20.

Reconnaissance survey for lateritic bauxite and associated REE mineralisation was taken up in and around Ksehkohlong area, east of Nongstoin, West Khasi Hills district. An area of 50 sq. km in and around Nongspung, Ksehkholong, Maukhaton, Salang, Lumrsiyang-Pamphyrnai and South of Markasa area was mapped on 1:12,500 scale. One small bauxite patch of dimension 50 m X 50 m and thickness around 50 cm was mapped in Village Pamphyrnai . A pit of dimension 2 m x 1 m x 1 m was dug on the northern side of the hillock and another pit of dimension 2 m x 1 m x 1.5 m at RL 1,640 m was dug on the southern side of the hillock in suspected cappings to check the mineralisation. Samples from different soil horizons for REE were collected. Chemical analysis results are awaited. The exploration work will continue in next field season 2019-20.

Directorate of Geology and Mining, Chhattisgarh

During 2018-19, G2 level exploration for bauxite in Sarbhanja block, Mainpat tehsil, Surguja district, Chhattisgarh was continued from previous field session. Exploration involved mapping of 0.78 sq. km on 1:4,000 scale; drilling of 278.10 m in 26 borehole; pitting of 18 cu. m and collection of 390 samples. Resources estimated under Indicated category was placed at 0.437 million tonnes. In

Dumarguda bauxite block, Surguja district, an area of 2.39 sq. km was mapped on 1:4,000 scale. About 39 drill holes were drilled to a cumulative depth of 447.90 m and 536 samples were collected for analysis. The total resources estimated was at about 7.77 million tonnes under Inferred category. During G3 level exploration in Dandkesra north bauxite block, Surguja district, an area of 2.35 sq. km was mapped on 1:4,000 scale, 34 boreholes to a cumulative depth of 365.40 m were drilled and 400 samples for chemical analysis were collected. The total resources estimated was at about 6.87 million tonnes (UNFC code 333). In Parpatia bauxite block, Mainpat tahsil, Surguja district, a G3 level exploration (NMET Project) undertaken involved mapping of 5.02 sq. km area on 1:4,000 scale; drilling of 122 boreholes to a cumulative depth of 1,540.60 m and collection of 1,608 samples for analysis. The total resources estimated was at about 12.62 million tonnes (UNFC code 333).

MECL

In Jharkhand, a G2 level exploration in Hanrup blocks on Serandag (Pat) plateau, Gumla district was carried out with the objectives to i) prove the occurrences of bauxite zones, assess the bauxite resources both quantitatively and qualitatively etc. The exploration comprised 84.20 m drilling in 4 boreholes and 74.00 m vacuum suction drilling in 4 boreholes. A total of 268 samples were collected for various studies/analysis.The total insitu net resources estimated for all categories in Hanrup block was (i) 0.461 million tonnes with average 45.53% Al_2O_3 and 4.77% SiO_2 at (+) 40% Al_2O_3 and (-) 7% SiO_2 cut-off; (ii) 0.29 million tonnes with average 47.37% Al_2O_3 and 2.55% SiO_2 at (+) 38% Al_2O_3 and (-) 5% SiO_2 cut-off ; and (iii) 1.56 million tonnes with average 39.76% Al_2O_3 and 6.63% SiO_2 content at (+) 30% Al_2O_3 and (-) 10% SiO_2 cut-off. The content of TiO_2 + Fe_2O_3 varied from 17.42 to 38.86%, vanadium from 779.8 ppm to 1,883.5 ppm, gallium from 69.30 to 19.0 ppm. The average content of vanadium and gallium was found to be negligible.

In Chhattisgarh, a G2 level exploration in Seraipani Dadar block, Pandaria tehsil, Kabirdham district involed mapping of 0.80 sq. km area on 1:2,000 scale, drilling of 210.55 m in 14 boreholes and collection of 407 samples for chemical analysis. A total of 2.23 million tonnes net in situ bauxite resources were estimated with an average grade of 31.61% Al_2O_3, 18.67% SiO_2, 26.93% Fe_2O_3, 4.08% TiO_2 & 17.81% LOI at (+) 30% Al_2O_3 cut-off.

Directorate of Geology and Mining, Maharashtra

During 2018-19, G2 level exploration for bauxite mineral was carried out in Kolhapur and Ratnagiri district, Maharashtra.

In Kolhapur district at Ibrahimpur an area of 20sq km was mapped on 1:25,000 scale and 30 samples were collected for chemical analysis. Objective of exploration was to locate occurrences of bauxite mineral in this area. Most of the area is covered by Deccan Trap of basalt formation of Upper Cretaceous to Lower Eocene age . At some places it is overlained by laterite. Scattered floats of laterite/bauxite and is noticed all along hill slopes, but the density of floats is less. Exploration is underway.

In Ratnagiri district at Sheel Taralwadi an area of 1.44 sq km was mapped on 1:5000 scale. A total of 36 boreholes to a cumulative depth of 483.5 and 346 samples were collected for chemical analysis. Objective of exploration was to locate occurrences of bauxite mineral in this area. Most of the area is covered by deccan trap of basalt formation of upper cretaceous to lower eocene age with gentle dips. At some places it is overlained by laterite. Laterite & bauxite occurring in this area are residual deposit. The occurrences are in the form of pockets & lenses. All over the plateau they are associated with laterite cappings & owe their origin to deccan trap. Occurrences of irregular but conspicuous development of medium to low grade bauxite were also noticed in the form of pockets & lenses. In the exploration area occurrences of laterite has been traced between 150 m to 250 m. Exploration is underway.

GMDC

In Gujarat, exploration in four mines, i.e., Daban Wamoti, Ratadia-Nagrecha, Nana Goniyasar and Wandh-1 of Calcinied bauxite Project, Gadhasis, Kuchchh district comprised excavation of 233 pits, drilling of 3,114.0 meterage in 100 boreholes and collection of 233 samples. A total of 4.87 million tonnes of bauxite reserve under UNFC code 111 were estimated in Daban-Wamoti, and Ratadia-Nagrecha mines.

Chhattisgarh Mineral Development Corporation (CMDC)

In Chhattisgarh, CMDC carried out exploration in four mines, i.e, Kudaridih, Narmadapur, Kamleshwarpur and Rupakhar in Surguja district that

comprised geological & geophysical mapping of 8.12 sq. km area on 1:1,000 scale, collection of 6,277 samples and drilling of 11,154.0 meterage in 875 boreholes.

Ferrous Minerals

CHROMITE

GSI

In Bihar, preliminary exploration (G3) for Cr, Ni and PGE undertaken in and around Lakrahi and Ganjana villages, Gaya district included detailed mapping of 2 sq. km area on 1:1000 scale and pitting & trenching of 202 cu.m. The mafic-ultramafic suite of rocks were found to occur as isolated lensoidal patches within the granitic rocks in the area. Detailed mapping was undertaken to delineate the different variants of rocks exposed in and around Village Lakrahi. The mafic rocks in the area are represented by variants of gabbro viz. pitted gabbro and noritic gabbro, whereas, the ultramafic rocks are represented by light green pyroxenite, cumulus pyroxenite and podded pyroxenite. The targeted lithology, i.e., the light green pyroxenite yielded "PGE of 766 ppb (FS 2016-17). High values of PGE have been obtained from the contact zone of light green pyroxenite with the gabbro. A total of nine bands of light green pyroxenite have been mapped with the help of off-set trenches. The continuity of the PGE-bearing light green pyroxenite has been established for 170 m length with a maximum width of 15 m. The chemical analysis of 98 trench and bedrock samples out of 400 samples showed insignificant values of total PGE (like 6 ppb, 7 ppb) and these were contrary to the higher analysed total PGE value of up to 766 ppb reported in field seasion 2016-17.

In Jammu and Kashmir, reconnaissance survey (G4) was carried with the objective to assess chromium, nickel, cobalt, copper and vanadium in ultramafic rock of Indus ophiolite belt. An area of 100 sq. km was mapped by LSM on 1:12,500 scale. A total of 25 samples from ultramafic contacts have been submitted for PGE and gold analysis. A major part of the area is inaccessible with elevation that ranged from 4,200 m to 5,465 m. Small discontinuous chromite bodies were observed in an area of about 1 sq. km; as such 11 chromite bodies have been observed at the north of Mankhang plain in peridotite. The dimension of the largest chromite body was 11 m x 9 m and smallest chromite body was 1 m x 1 m. Only surface extension of chromite bodies has been noticed. The chemical analysis results of vanadium showed promising values in 5 samples collected from north of Mankhang plain area. The maximum value of vanadium is 1,112 mg/kg.

Reconnaissance survey for nickel, chromium, gold and PGE mineralisation in Shilakong ophiolite/ Spongtang ophiolite in Photaksar, Machu, Shilshi La area of Leh and Kargil districts was taken up in parts with an objective to delineate the potential zone of chromium, nickel, Au and PGE mineralisation. An area of 55 sq. km was mapped on 1:12,500 scale. The Stream Sediment Samples were collected from the 1st /2nd order tributary stream of Photang and Spang Nadi. The PCS samples were collected from the different rock units exposed in the study area. The analysis of 20 samples showed MgO values ranging from 34.25% to 40.18. The analysis of 20 BRS samples showed the nickel value in the range from 900 to 2,000 ppm.

In Maharashtra, G-4 stage investigation was carried out in Vaghmala-Morle area in Sindhudurg district, with the objective to assess the potentiality for chromite and associated minerals, nickel, iron & manganese mineralisation in mafic/ultramafic complex. An area of 100 sq. km was covered on 1:12,500 scale and stream sediment, bed rock and pit samples were collected. The outcrops of banded iron formation were seen in and around Kudase, north of Sasoli, Kumbrol, Sateli-Bhedshi, Mahaduvadi and Morle area. Serpentinite and talc-chlorite schist are the potential rocks for chromium and nickel mineralisation mainly exposed in western part of the mapped area. The analytical results of stream sediment samples show chromium values ranging from 90 ppm to 32,360 ppm, Ni values from 58 ppm to 1,335 ppm, Fe values between 2.8 % and 30.7 %, Mn values from 640 ppm to 10,000 ppm and vanadium values between less than 25 ppm and 1,040 ppm. Out of the 16 bedrock samples collected from serpentinite, 13 samples show Cr more than 2,700 ppm and 14 samples show Ni more than 1,000 ppm. The maximum values of chromium and nickel are 2 % and 0.2 % respectively. Out of 23 BRS collected from talc-chlorite schist, 16 samples show Ni more than 1,000 ppm and 11 samples show Cr more than 4,000 ppm. The maximum values of chromium and nickel are 6.86% and 0.19% respectively. All twenty six samples of BIF show iron values more than 39.66 % and the maximum value is 57.70 %. Out of 26 samples

of BIF, 10 samples show Mn more than 3,900 ppm and the maximum value is 23,700 ppm. Out of 39 samples of laterite, 16 samples show iron values from 28 % to maximum of 37.42 % and 19 samples show Mn more than 0.3% and maximum Mn value is 2.56 %. Out of 20 pits, 6 pits have been done in serpentinite and 14 pits in talc-chlorite schist. Samples from 10 pits in talc-chlorite schist show the value of chromium more than 5,000 ppm and Ni more than 1,000 ppm and the maximum value of Cr is 8.2 % and the maximum value of nickel is 0.19 %. Pits (2 nos.) in serpentinite show chromium more than 5,000 ppm and only one pit show Ni more than 1,000 ppm. Based on analytical results, 8.96 sq. km area in serpentinite and talc-chlorite schist demarcated as an anomalous/potential zone for chromium and nickel mineralisation.

In Manipur, reconnaissance survey (G4) was taken up with an objective to locate mineralisation of chromium, nickel, PGE and associated base metals in Singucha-Khangkhui-Gamnonm area. A total of 50 sq. km area was mapped on 1:12,500 scale. A total of 28 samples were selectively collected for PGE analysis.

Directorate of Geology, Odisha

In Odisha, Directorate of Geology continued exploration for chromite in Madhuban area in Keonjhar district. The work included geophysical mapping of 0.8 sq. km area; drilling of 3 boreholes to a cumulative depth of 150.60 m and collection of 11 core samples for chemical analysis. There is no significantly perceptible chromite mineralisation noticed in the area. During exploration for chromite in Mathkargola area, Dhenkanal district, an area of 150.00 sq. km was mapped on 1:25,000 scale & 1.05 sq. km area on 1:5,000 scale. About 74.16 cu. m material was excavated in 15 pits and 41 samples were collected for chemical analysis. The area has been recommended for geophysical prospecting.

OMC

During 2018-19, OMC carried out exploration for chromite in mining leases held by OMC in Jajpur district, viz. (i) South Kaliapani: mapping on 1:1,000/1:2,000 scale in 16 ha/101 ha, respectively, chemical analysis of 1,039 samples and 5,062.20 m core drilling in 22 boreholes; (ii) Sukrangi: mapping on 1:1,000 scale in 33 ha, chemical analysis of 408 samples and 3,115.0 m core drilling in 12 boreholes; (iii) Saruabil - Sukrangi: Total core drilling of 169.40 m in 1 borehole; In Keonjhar district-Bangur mine: mapping on 1:200 scale, chemical analysis of 823 samples and 5,447 m core drilling in 20 boreholes. Reserves estimated during the year 2018-19 are placed at 1.20 lakh tonnes of (+) 30% Cr_2O_3.

Iron Ore

GSI

In Andhra Pradesh, a general exploration of G2 stage was initiated around Obulapuram, Anantapur district on the request of DMG, Andhra Pradesh, with an aim to add resource of iron for establishing Kadapa Steel Plant. The Obulapuram area lies in the southeastern part of the Sandur Schist Belt. Iron ore occurs mainly as BMQ and BHQ in the area. Three prospecting blocks for drilling (Block -1: 0.52 sq. km, Block-2: 1.64 sq. km and Block-3: 3.84 sq. km) were identified during the detailed mapping. In Block 1, iron bands were categorised under massive haematite ore (64% to 65% Fe; length: ~450 m, width varies from 3 to 40 m), friable haematite ore (55% to 64 Fe %, length ~550 m, width varies from 20 m to 200 m) and alternate bands of haematite and argillite (47 to 49 Fe%; length ~200 m, width varies from 20 m - 50 m). In Block 2, BMQ bands are of 1.5 km in length with width varying from 10 to 60 m and comprised 30 – 40% Fe. In Block 3, two 5.6 km long BMQ bands have been demarcated (width varies from 10 m to 40 m) with 25–40 % Fe. All the three blocks of Obulapuram Iron Ore project come under Bellary RF and Mincheri RF. Drilling could not be started due to non-receipt of Forest Clearance.

In Bihar, a preliminary exploration for vanadium bearing magnetite-ilmenite mineralisation around the areas North-east of Patal Ganga and East of Sapneri villages, Gaya and Jehanabad districts was taken up in Patal Ganga and Sapneri blocks by means of detailed mapping (2 sq. km), bedrock sampling (50 nos.), pitting/trenching (100 cu.m) and drilling (415.5 m). Magnetite bodies in Sapneri block have limited surface dimension —the maximum being 100 m x 20 m whereas in Patal Ganga block the exposed ore body is of 200 m x 200 m surface dimension. Available analytical results of 19 BRS from magnetite bodies in Sapneri block indicate 40.17 % to 56.63 % Fe (average 49.57 %), whereas, 25 BRS collected from magnetite bodies in Patal Ganga block show 44.92 % to 54.13 % Fe (average 50.54 %). Pit/trench samples indicate $Fe_{(t)}$ ranging from 18.99 to 54.13 % (average 45.19 %, n=45) in Sapneri block and from 20.06 to 51.4 % (average 40.75 %, n=42) in Patal Ganga block. Vanadium

concentration of 1,597 ppm to 3,388 ppm from 3 BRS and 195 ppm to 4,190 ppm from 22 PTS are recorded in Sapneri block. A total of 6 BRS in Patal Ganga block yielded 3,868 ppm to 8,776 ppm of vanadium and 2 PTS showed vanadium concentration of 4,365 ppm and 6,406 ppm respectively. Drilling was carried out on 100 m x 100 m grid in Patal Ganga block to know the depth persistence of the ore body. Six boreholes were completed and one borehole is proposed to be drilled 100 m north of Borehole no. BRPG-2. The work is under progress.

In Chhattisgarh, a reconnaissance survey (G4) for iron ore in and around Gopalpur area, Mahasamund district, was taken up. The project comprised Large-Scale Mapping of 100 sq. km on 1:12,500 scale, with 50 cu.m pitting/trenching. In the area, the banded magnetite quartzite (BMQ) was found to occur as enclaves in granite gneisses at higher elevated area of Tonidongri, Bijepur, Khairkuta, Sapos and in Village Gaboud. Major occurrences of BMQ were located in the hill south of Bijepur (700 m X 400 m), west of Gaboud (300 m X 200 m), in a mound north of Sapos (200 m X 30 m) and in the western side of Tonidongri hill near Gopalpur-7 (600 m X 30 m). Major element chemistry of the representative BIF samples showed that SiO_2 and Fe_2O_3 constituted nearly 93.35% of the bulk of the banded iron formations. Eight bedrock samples of BMQ yielded up to 59.82% of Fe_2O_3 content with an average of 47.72% SiO_2 and Fe_2O_3 content of the studied banded iron-formations showed negative correlation with SiO_2. Average contents of SiO_2, Al_2O_3, CaO, MgO, Na_2O, K_2O, MnO, TiO_2, P_2O_5 analysed in surface samples were 45.63%, 0.066%, 1.58%, 2.28%, 0.0386%, <0.05%, 0.093%, <0.1%, and 0.04% respectively.

In Jharkhand, a preliminary exploration (G3) for iron ore and manganese ore in the gap areas near Baraiburu in the northwestern part of Horse-shoe syncline, West Singhbhum district, was continued from field session 2017-18 in the Baraiburu Block — part of the Jamda-Koira basin of Iron Ore Group. During field session 2018-19, detailed mapping of 1 sq. km area on 1:4,000 scale, a total of 837.85 m drilling in eight boreholes, bedrock sampling (25 nos.), trenching sampling (25 nos.) etc. were carried out. The geophysical survey (GP and magnetic) of 4 L km and 204 m of GP borehole logging (electrical) were carried out. Iron and manganese ore mineralisation was seen to be concentrated in the eastern side of the block. The exposure of manganese ore body seemed very small. The analytical results of Trench no. PTS-14 revealed the maximum value of Fe to be 61.97% with an average of 60.09%, while SiO_2 and Al_2O_3 averaged 4.91% and 1.79% respectively. In PTS-15, maximum value of Mn was 15.54% with an average of 15.13% Mn, while SiO_2 showed 3.53% & Al_2O_3 7.03%. Analytical results of core samples of borehole showed the average value of Mn as 0.026%.

In Odisha, a general exploration (G2) for iron ore in Nuagan west block, Kendujhar district was carried out to assess the iron ore potential. Detailed geological mapping of 0.65 sq. km on 1:2,000 scale along with 25 cu.m pitting/trenching and 2,000 m drilling were carried out. Within the freehold area, ore body is exposed on the surface for a maximum length of 400 m for both across and along the strike. A total of 2,000 m drilling in 25 boreholes were carried out. All the boreholes intersected mineralised zones except five boreholes. The thickness of ore zones (including low-grade ore) intersected as per visual estimation showed variation from 2.00 m to 52.70 m. Maximum and minimum thickness of ore zones varied from 52.70 m to 2.00 m. The borehole intersected mineralised zone comprised lateritic ore, reddish to brown powdery ore, hard laminated ore, lateritised hard laminated ore, minor soft laminated ore with intercalations of shale/ferruginous shale and minor pieces of banded haematite chert/ BHJ.

In Alaghat west block in Sundargarh district, detailed mapping of 0.50 sq. km was carried out. An iron ore body of length 300 m with width varying from 30 to 100 m was mapped. A total of 251.30 m drilling was carried out in four boreholes. The cumulative thickness of the ore zone intersected in the boreholes varied from 20.00 m to 60.0 m. The maximum and minimum values of total Fe in the borehole cores varied from 24.66% to 64.62%. Other than the core samples, 5 water samples, 10 soil samples for abiotic parameter studies and one surface sample for bench-scale beneficiation studies were collected.

In Sambalpur district, a reconnaissance survey (G4) for iron and manganese ore was carried out in Tikiba-Phasimal-Ardapal area. The study area falls within the transition zone of Singhbhum craton and Eastern Ghat mobile belt. The exploration work comprised Large-Scale Mapping of 100 sq.km area on 1:12,500 scale and 50 cu. m of pitting and trenching. A total of 108 bedrock, 45

pit/trench samples, 11 PCS, 15 for REE and 5 samples for Au were collected for chemical analysis. Four zones (3 zones from BRS samples and 1 from PTS samples) of low- grade iron ore were delineated, i.e., 49.5% Fe over 10 m in south of Tikiba, 50.9% Fe over 10 m in south of Kirmaloi, 54.64% Fe over 5 m in north of Kirmaloi and 46.8% of Fe and 4.88% of Mn over 10 m in Fe-Mn laterite of Fashimal. Surface trenching and pitting as well as field observation in Village Beluamal and Tikiba reveals surfacial nature of iron and manganese mineralisation. Iron ore viz. haematite, goethite, limonite and manganese ore like pyrolusite and psilomelane are observed associated with garnetiferrous quartzo-felspathic gneiss of transitional zone.

A preliminary exploration (G3) for iron ore in Gandhalpada west block, Kendujhar and Sundargarh districts was taken up to assess the iron ore potential for augmentation of resources. Detailed mapping of 2.00 sq. km. was carried out on 1:4,000 scale. The mapped area comprised of lateritised hard laminated iron ore, fragmentary iron ore, shale, laterite and soil. Out of twelve boreholes drilled to a cumulative depth of 1,143.55 m, 6 boreholes intersected cumulative ore zone of 34.00 m, 13.00 m, 11.00 m, 21.00 m, 10.00 m and 5.00 m. In two boreholes, thick zones of 46.00 m and 18.00 m of peat/lignite were intersected. Resins, seed and wood materials were also observed in both the boreholes. This is the first reported occurrence of peat/lignite zone in the Bonai-Kendujhar Belt. Preliminary iron ore resources estimated over two cross-sectional lines in the block (as per the available chemical data and also by visual estimation) is placed at 27.60 MT at 45% Fe cut off.

A preliminary exploration (G3) for iron ore in Kedesala NE block, Sundargarh district comprised mapping of 1.00 sq. km area on 1:4,000 scale, drilling of 41.70 m and pitting/trenching of 50 cu.m. The iron ore occurs as capping and as isolated lenses over the BHJ or as gently dipping bands over ferruginous shale and occasionally over volcanics. At places near hinge of folds, small lensoidal bodies of lateritic and massive iron ore are developed. The iron ore in the block are in the form of SLO, powdery ore, blue dust, lateritic iron ore and ferruginous shale. As noticed in some boreholes, the soft laminated ore is underlain by ferruginous shale and blue dust zone, followed by BHJ & BHQ, whereas in others it directly rests on BHJ. The iron ore in the block extends for a strike length of about 2 km with a maximum width of 400 m but the average width from 250 to 300 m. Analytical result of one borehole showed high-grade iron ore of 6 m with average grade of 57.91 % Fe and low- grade iron ore of 22 m with average grade of 49.47 % Fe.

In Telangana, a reconnaissance survey (G4) was taken up to explore iron ore potential in Ragampet and Dumalkunta blocks in Karimnagar, Peddapalli and Jagtial districts. In both the blocks, iron ore occurs as banded magnetite quartzite (BMQ) band(s) and restricted to top of hills and mounds. The iron bands are found as bouldery outcrops and are discontinuous in nature. BMQ bands are of variable width, length and strike and consist of micro to macrobands of magnetite. Iron to silica ratio varies from 1:2 to 1:5. Grunerite is found in variable proportion along with quartz and magnetite within BMQ. Disseminated magnetite grains and magnetite inclusions are found within grunerite. A total of 15 hills bearing BMQ in Dumalkunta and Ragampet blocks were mapped on 1:12,500 scale. Length of iron bands ranges from 50 m to 850 m with average width of 15 m. Kammarikhanpet and Pattipaka Hill-I and Hill-2 are the major BMQ bearing hills of Ragampet block. Kammarikhanpet Gutta (Hill) and Pattipaka Hill -1 host a single linear BMQ band of strike length 950 m and 300 m respectively with average width of 25 m. In Pattipaka Hill-2, Band-II is the major band with 250 m length and 59 m width. The chemical analysis of BMQ samples showed Fe content in the range of 30-35% and silica from 40-50%. Five scout boreholes were drilled (two in Dumalkunta block and three in Ragampet block). Surface mineralised zones were intersected in boreholes and in most of mineralised zones were found to be divided into number of smaller bands.

The reconnaissance survey (G4) carried out for iron ore in Gollapalli block, Karimnagar district comprised Large Scale Mapping of 100 sq. km area on 1:12,500 scale. A total of 26 BMQ bands having length varying from 70 to 600 m and width varying from 5 to 60 m were identified. Only 3 bands were seen with length more than 400 m and average width of 50 m. The BMQ bands have alternate

magnetite and silica-rich layers in 25:75. The petrographic study revealed that the main ore is magnetite and associated gangue minerals are quartz, grunerite and orthopyroxene. The iron-bearing silicates (grunerite, orthopyroxene) contributed less than 5% of the total iron content in BMQ and up to 10% of the magnetite grains got altered along the boundaries, fracture planes into martite owing to martitization. The analytical results of BRS samples showed Fe_2O_3 value varying from 14.53% to 59.07% with an average of 44.34% Fe. The SiO_2 ranged from 28.58 to 82.84% and Al_2O_3 from 0.05 to 7.68%. The average Fe_2O_3: SiO_2+Al_2O_3 ratio is 44.35%:50.3%. The Fe values of the BMQ samples were found to be varying from 10.1% to 41.3% with an average of 31.03%. Considering the prognosticated depth of 10 m and average bulk density is 3.37, the inferred resource is expected to be estimated to the tune of 3.40 million tonnes with average Fe content of 31.03%. It is of low-grade iron ore with high silica and alumina. A carbonatite body about 1 km east of Village Rapalli of 200 m length and width varying from 2 to 3 m was identified. From the Scanning Electron Microscope study, different mineral phases like calcite, dolomite, magnetite and Ti-Y rich REE phase were identified.

Directorate of Geology and Mining, Maharashtra

During 2018-19, exploration for iron ore was carried out in Chandrapur district to explore deposite to delineate the iron ore body at Metapar & Shirur block.

In Chandrapur district at Metpar an area of 2.6sq km was mapped on 1:1,25,000 scale. A total of 17 boreholes to a cumulative depth of 2571.5 were drilled and 253 samples were collected for chemical analysis. Objective of exploration was to to explore the iron ore deposit to delineate the iron ore body with the extension of the earlier identtified during G4 reconnaissance survey. The deposit lindicates strike extension, depth persistence, structural behavior etc. . The BMGQ shows alternate bands of quartz (silica) rich layer and magnetite layer (ferruginous layer). Grunerite occurs in between these two layers. The disseminated pieces of these BMGQ are found on the surface, however no surface outcrops are seen as such. Reserves/resources are yet to be calculated.

In Chandrapur district at Shiwra block an area of 0.24 sq km was mapped on 1:1,25,000 scale. A total of 4 boreholes to a cumulative depth of 489.0 were drilled and 41 samples were collected for chemical analysis. Objective of exploration was to to explore the iron ore deposit to delineate the iron ore body with the extension of the earlier identtified during G4 reconnaissance survey. The deposit lindicates strike extension, depth persistence, structural behavior etc. . The investigation area broadly comprises of Granite gniesses belonging to the Archean Bengpal/ Amgaon Gneissic Complex with enclaves comprising ultramafic bodies, banded magnetite grunerite quartzite (BMGQ), amphibolites and pyroxenite with vanadiferous magnetite bands. The major lithounits of the area under study are chiefly gneiss and migmatite gneisses in close association with migmatites are well exposed in the southern part of the area viz. Doma, Kawadsi,Jambhulghata and Bhisi. The Bengpal gneiss hosts many enclaves of older supracrustal i.e.Sukma Group of rocks.

Directorate of Geology, Odisha

During 2017-18, Directorate of Geology, Odisha has continued exploration to assess iron ore resources in Dholtapahar, Sundergarh district. An area of 0.605 sq.km was mapped on 1:2,000 scale and 10.00 cu.m material excavated in one pit. Cumulative drilling of 982.25 m was completed in 19 boreholes and 366 samples were collected for chemical analysis. The total resources estimated were at about 23.922 million tonnes. During exploration for iron and manganese ore in SGB mines in Keonjhar district, 111 boreholes were drilled to a total depth of 6,076.00 m and 2,119 core samples were collected for analysis. Exploration in the area will continue after clearance from MoEF. In Sundargarh district, exploration for iron and manganese ore in Ganua area was carried out by mapping of 1.10 sq.km area on 1:2,000 scale. A total of 4 boreholes were drilled to a depth of 31.91 m and 15 samples were collected . The isolated patches of lateritic iron ore with Fe content varying from 42.59 to 59.02%. The area is not potentially mineralised.

Directorate of Mines & Geology, Rajasthan

In Jaipur district, exploration to prove iron ore reserves was taken up near Village Bagawas,

Tehsil Viratnagar. During exploration work, iron ore observed in tubewells were of moderate geophysical values in the area. About 63.41 LKM area was covered by geophysical mapping. Besides, an area of 5.00 sq.km was mapped on 1:10,000 scale.

In Alwar district, exploration for iron and other associated minerals was taken up near Village Bahali, Simbu ka Bas, Moti ka Bas, Fetehpura, Kharkari Chavand singh, Andhwari, etc. in Rajgarh and Raini tehsils. An area of 3.0 sq.km was mapped on 1:4,000 scale and 8 samples were collected.

Directorate of Geology & Mining, Uttar Pradesh

In Uttar Pradesh, a G4 level exploration was continued from previous field session with the objective to explore iron ore deposit in solda-uudana area, Lalitpur district. An area of about 60.00 sq.km was covered under geological traversing and the same was mapped on 1:12,500 scale. About 128 cu.m pitting work was done in 8 pits. A total of 433 grid and pit samples were collected for chemical analysis. About 12.00 sq.km area seems to be dominated potentially by iron ore especially haematite, limonite and laterite.

OMC

During 2018-19, OMC carried out exploration in its nine iron mines and two iron & magnanese mines located in Keonjhar and sundargarh districts, Odisha. Exploration activities were carried out in (i) Daitari mine with an objective to prove the ore body up to a depth on 810 mRL for detail mine planning. Quarry area of 74 ha was mapped on 1:2,000 scale, 25 boreholes to a cumulative depth of 3,609.40 m was drilled and 2,534 samples were collected for anaysis. A tentative 25.76 million tonnes of additional reserves were assessed. The total re-assessed resources of the mine was placed at 202.16 million tonnes; (ii) Kumritar mine with an objective to delineate the ore disposition and assessement of reserves. An area of 20 ha was mapped on 1:2,000 scale and 6 boreholes were drilled to a total depth of 485.5 m. The total resources of the mine is placed at 178.45 million tonnes including 42.85 million tonnes of (+)45% Fe resources; (iii) Rantha mine where an area of 20.0 ha was mapped on 1:2,000 scale and the re-assessed resources were placed at 18.70 million tonnes including 2.47 million tonnes of 45-58% Fe; (iv) Koira-Kasira mine where an area of 20 ha was mapped on 1:2,000 scale and the total resources estimated was at 7.77 million tonnes including 4.97 million tonnes of (+)45% Fe; (v) Koira-Bhanjapalli mine where an area of 20.0 ha was mapped on 1:2,000 scale and resources estimated were at 6.95 million tonnes including 2.14 million tonnes of 45-58% Fe; (vi) Tiringpahar mine where an area of 79.3 ha was mapped on 1:1,000 scale; (vii) Khandbandh mine where an area of 45 ha was mapped on 1:1,000 scale; (viii) Dubna-Sekradihi Fe-Mn mine where as area of 62.02 ha area was mapped on 1:1,000 scale; (ix) Seremda Bhadrasahi Fe-Mn mine where an area of 21.5 ha was mapped on 1:500/1:1,000 scale, drilled 16 boreholes for cumulative depth of 299.9 m. were drilled and 255 samples analysed. During the year, about 0.05 million tonnes of 45-58% Fe was estimated. The total resources in the area was placed at 11.92 million tonnes; (x) Gandhamardan block B where an area of 50.00 ha was mapped on 1:1000 scale, 755.00 meterage in 20 borehole and 21 samples were collected for chemical analysis.

Manganese Ore

GSI

In Andhra Pradesh, reconnaissance survey (G4) for manganese and graphite mineralisation was carried out around Kondamosuru area, Vizianagaram and Visakhapatnam districts. The survey subsumed mapping of 100 sq. km area on 1:25,000 scale. The manganese mineralisation was found to be present in the form of manganiferous zone, which showed intimate association with quartzite. It occurs as bands, lenses and floats of varying dimensions. The main manganese -rich band is of approximately 1 km strike length and varies in width from 5 m to 10 m from Kondamosuru to Mulagapadu. At Silavalasa, the manganese band was observed associated with calc-granulite. The dimension of the band is around 200 m x 5 m. Some other occurrences were observed at SW of Mulagapadu of 50 m x 10 m and 30 m x 5 m at Allampadu . Float ores are observed at south of Kondaluddandi with a cumulative dimension of 20 m x 5 m and at east of Gumaripadu with a cumulative dimension of 50 m x 10 m. Analytical values of manganese (Mn) in bedrock samples collected from the Mn enriched horizons ranged from 0.03% to 39.64%. At Satapi, graphite mineralisation with dimension of 500 m x 50 m was observed. In the hand specimen, graphite was observed as flakes. At places, it is zoned but mostly it is disseminated with a visual estimation of up to 10% graphite.

During reconnaissance survey (G4) for manganese ore in and around Garikipenta-Vommi block, Vizianagaram district, an area of 100 sq. km was covered by large scale mapping (1:12,500). Manganese zone has been identified in the Solipikonda hill to the north of Kondapeta. It occurs as continuous bands in the contact of calc-granulite and garnetiferous quartzo-feldspathic gneiss of Khondalite Suite. Surface geometry of the mineralised zone is oval-shaped pinching out towards NW and SE. It has a strike length of 309 m with varying width of 70 to 80 m. The zone is comprised of mainly pyrolusite with occasional occurrence of psilomelane. The ore minerals are friable in nature. Analytical result of bedrock samples showed encouraging values of MnO up to 33.61%. Another manganese-rich zone has been identified in the Gumpumkonda hill to the north-east of Garikipeta. This mineralised band is of lenticular shape having a strike length of 110 m and exposed width of 20-25 m. Pyrolusite is the predominant ore mineral in this band. Analytical result of bedrock samples showed MnO value ranging up to 18.0%. The third manganese mineralised zone of length of about 200 m and width 30 m has been identified in the south west of Village Jaggarajupeta.

A spill over G2 level general exploration for manganese ore in Devada block, Vizianagaram district was taken up in the instance of State Govt. which included 0.2 sq. km of detailed mapping and 1,066.85 m drilling in field session 2018-19. The Devada block lies within the Garividi manganese belt of Vizianagaram district. The manganese mineralisation occurs in the form of sub-horizontal to gently incline pocket/lensoid type bodies with pinching and swelling nature. Two lenses have been delineated. The southern lense is traced to a strike length of 300 m and 100 m width with average thickness of 30 m. The strike length of northern lense is 500 m long and 300 m wide with average thickness of 48 m. Manganese mineralised zones have been intersected at different depths in the boreholes of northern and southern lenses. The analytical results of core samples showed MnO, FeO, SiO_2 and P_2O_5 content varying from 1.4 to 70.2%, 0.5 to 45%, 2.3 to 52.15% and 0.6 to 2.8% respectively. An average of 90 m long manganese zones in southern lense and 135 m long manganese zones in northern lense (based on 10% cut-off grade of MnO) have been delineated respectively. Based on availability of chemical data, resource (in part) of Devada block is estimated as 7.6 million tonnes with average grade of 23.6% Mn.

Reconnaissance survey (G4) for manganese ore taken up in Chinnabantupalli and Bakuruvalasa blocks in Vizianagaram and Srikakulam districts comprised Large Scale Mapping of 50 sq. km followed by detailed mapping of 0.5 sq.km. In Chinnabanthupalli block, major rock types encountered were garnet sillimanite gneiss, calc granulite, pegmatite. Three old manganese pits were mapped which are located within the weathered garnet sillimanite gneiss. Old pit examinations indicated that manganese occur as lensoidal bodies and are highly pinched and swelled type in nature. Pyrolusite and wad are the main manganese ore of the area. One borehole drilled at Chinnabanthupalli block and mineralisation was not intersected in this borehole. The Bakuruvalasa block (0.25 sq. km) is located in between the two active manganese mines. Manganese pit inside the block was of 180 m long with width varying from 15-20 m with variable depth of 8 m to 30 m. Based on the data collected from the both active mines, it is noted that the mineralisation is located at the contact between weathered feldspathic quartzites and manganiferous quartzite as narrow linear band of 3-5 m width extending over a strike length of about 500 m. These litho contacts and mineralisation have been interpolated to the block area under investigation and inferred mineralisation demarcated.

A G4 stage reconnaissance survey for manganese mineralisation was taken up in Yenubaruva block with an objective to delineate the zone of manganese mineralisation and to assess the grade and resources in the block under reference. The dimension of the manganese mineralisation occurs discontinuously up to a length of 600 m that varies from 2 m to 5 m in width and 2 m to 15 m in length. Surficial coating of manganese and old pit indicated that manganese occurs as lensoidal bodies, which are highly pinched and swelled in nature. Pyrolusite and psilomelane are the main manganese ore in

Table - 6:Exploration for iron ore by MECL & NMDC 2018-19

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (ha)	Boreholes	Meterage		
MECL							
Odisha							
Sundargarh	Jhumka-Pathriposhi	1:2000	157.00	56	3967.60	5701	A total 145.50 million tonnes iron ore resources under UNFC code 332/331 have been estimated with the average grade of 56.14% Fe, 6.36% SiO_2 and 6.52% Al_2O_3 over a strike length of 2387 m.
Karnataka							
Chitradurga	Shri M D Rami Reddy	1:1000	19.46	-	-	-	Since part of the area falls in forest land, no exploratory drilling could be done.
Jharkhand							
Singhbhum west	Meghahatuburu	-	-	12	500.00	500	Borehole data indicates that ore types are irregularly distributed both laterally and vertically. The quality of ore improves with increase in depth. In some of the boreholes ore zones are reported below the parent rock BHQ. Resources has not been estimated.
Chhattisgarh							
Balod	Mahamaya mine of SAIL	-	-	3	130.00	87	The resources have not been estimated.
Rajasthan							
Jhunjhunu & Sikar	Kanawat-Chala-Karath-Bagholi area	1:12500	129.00	10	718.50	155	The total geological resources of both haematite & magnetite ore ore estimated in the sector-A on western limb and sector-E on eastern limb is about 3.75 million tonnes with 48.60% Fe, 21.93% SiO_2, 2.23% Al_2O_3, 0.53% P and 0.80% LOI (UNFC 333).
NMDC							
Karnataka							
Ballari	Kumaraswamy iron ore mine-B and C block	-	-	51	3553.00	1166	Total resources as on 1.4.2019 are estimated at 225.06 million tonnes.
Chattisgarh							
Dantewada (South Baster)	Bailadila Iron ore Mines Bacheli D-5	-	-	50	5259.00	-	-
	Kirandul complex Deposit-11MZ (11B,11C)	1:2000	-	24	1995.00	-	Entire lease area mapped on 1:2000 scale. Reserves estimation is under process.
	Kirandul complex Deposit-14MZ	1:2000	322.37	10	919.00	-	Reserves estimation is under process.
	Kirandul complex Deposit-14 NMZ	1:2000	506.74	14	1995.00	-	Reserves estimation is under process.

(Contd.)

the area. From the analytical results, nine channel samples showed MnO percentage varying from 7.94% to 16.91%.

During reconnaissance survey (G4) for manganese and graphite mineralisation around Ippakonda area, Srikakulam and Visakhapatnam districts, an area of 100 sq.km was mapped on 1:12,500 scale with the objective to delineate potential zones of manganese and graphite. Disseminated graphite specks have been observed at a few places in association with Khondalite. SEM analysis revealed presence of monazite, zircon, baddeleyite (rare zirconium oxide) and barium-bearing feldspar. The garnets are of pyrope, almandine, and spessartite and grossular variety. A few grains of apatite, rutile, ilmenite, pyrrhotite and allanite were observed.

In Karnataka, a G3 level preliminary exploration was taken up to assess manganese and cobalt potential in Tarlagatta area, Shimoga district. A total of 2.0 sq. km were mapped on 1:2,000 scale along with collection of 66 trench samples, 91 bedrock samples and 380 core samples for assessing potentiality of manganese, cobalt and other associated elements. Manganese mineralisation is hosted in the brecciated cherty quartzite and argillite. The cherty quartzite unit is extremely brecciated and the Mn-Fe mineralisation occurs as fracture fill veins of different dimensions. A total of 1,199 m of subsurface drilling were carried out. The thickness of mineralised zone (including argillite and brecciated cherty quartzite) ranged from 12 to 20 m. In one borehole, the thickness of mineralised zone was more than 40 m out of which an enriched manganese zone 32 m thick was observed along the borehole. In other boreholes, the width of mineralised zone ranged from 20 to 35 m. The analytical result received shows maximum value of cobalt in the range of 0.18% to 0.27% with MnO in the range of 14.37% to.32.9 %.

In Odisha, preliminary exploration (G3) for manganese was carried out in the Balikhamar block in Bolangir district. The area forms the south-eastern part of the Precambrian Eastern Ghat Granulite belt. The major rock types exposed were granite gneiss, quartzite, khondalite and calc-silicate. Laterite occurs as a thin veneer over the khondalite. The manganiferrous zone is confined to khondalite suite of rocks. The ore body exposed near Village Balikhamar has width of around 10 m. The mineralisation is structure controlled following the foliation of the rock. A total of 785 m of drilling in 13 boreholes along with pitting and trenching of 100 cu.m have been carried out to know the strike and depth persistence of Mn band. In the boreholes, manganese mineralisation up to 3 m has been intersected at different depths. The ore minerals are mostly pyrolusite and psilomelane.

G3 stage preliminary exploration for manganese was carried out in Boirani-Sadabartan area, Ganjam district, with an objective to delineate the potential zones of manganese mineralisation and evaluate the economic potentiality for future exploration. An area of 2 sq. km was mapped on 1:2,000 scale along with bed-rock sampling (78 nos.), pitting/trenching (120 cu.m) and drilling to understand the nature and disposition of different litho-units and to assess their potentiality for manganese mineralisation. A total of 205.30 m drilling were carried out in 3 boreholes. The boreholes were drilled at 100 m interval along the strike. Three boreholes were planned on eastern and western part of the block near Boirani-Sadabartan area, mapped during field session 2018-19, to establish the sub-surface continuity of manganese ore band established on the surface by way of trenches over 500 m strike length but no ore zone was intersected. Detailed geological mapping has revealed two discontinuous manganese ore bands which have been exposed in outcrops and in trenches. Its width varies from 3 m to 4 m and its strike continuity has been established for 110 m and 30 m respectively. The ore body within this zone occurs in the form of lenses, stringers, pockets and as fragmented bands.

Directorate of Geology and Mining, Maharashtra

During 2018-19, exploration for manganese ore was carried out in Bhandara & Nagpur districts. Objective was to delineate the manganese deposit & to calculate the reserves/ resources of manganese ore.

In Bhandara district at Alesur-Gonditola block an area of 9 sq km was mapped on 1:25,000

scale & 3.72 sq km area on 1:5000 scale involving 2 boreholes at a cumulative depth of 374 m. Objective of exploration was to delineate the manganese deposit & to calculate the reserves/ resources of manganese ore. The area covered fall in Alesur, Gonditola and Itapur village. Regionally the area marked by ENE – WSW trend. The prominent topographic features are the Chikla and Sitasaongi hills marked by the presence of Manganese ore horizons. The surrounding low lying area is mostly underlain by Tirodi gneisses, with linear bands of Mansar and Sitasaongi formation. In the area exposed rock formation belongs to Tirodi, Sitasaongi and Mansar formations and manganese ore horizon with intrusive quartz veins and pegmatities. The manganese ore horizon occurs in the lower part of sequence of meta- sedimentary rocks of Sausar group of Pre – Cambrian age.

In Hiwara block a total of 3 boreholes were drilled at a cumulative depth of 247 m & 5 samples were collected for chemical analysis. Objective of exploration was to delineate the manganese deposit of Hiwra block & to calculate the reserves/ resources of manganese ore. The Hiwra block in Mohadi tehsil of Bhandara district is a part of Sausar belt in Maharashtra known for manganese occurrences. G4 exploration was done with the objective of demarcating the rock types of manganese bearing Mansar formation and assessing the manganese ore resource in the block.

In Nagpur district at Madari-Panchala block 2 boreholes were drilled to a cumulative depth of 261 m & 6 samples were collected for chemical analysis. Objective of exploration was to delineate the manganese deposit of Madari-Panchala area & to calculate the reserves/resources of manganese ore. MECL carried out regional exploration (G4 level) and concluded that the manganese mineralization and associated gondite occur as four discontinuous bands trending WNW-ESE, separated by quartz muscovite biotite schist. Four no. of scout boreholes were taken by MECL in the area to know the strike and dip continuity of Manganese ore lenses.Among the four boreholes taken by MECL mineralized zone encountered in three boreholes MMLM-1, MMLM-2 & MMLM-3. In MMLM-1 mineralised zone encountered at the depth of 59.50 m and 66.73 m with the thickness of 2.00 m & 2.97 m respectively. Mineralised zone encountered in MMLM-2 at the depth of 47.75 m and 50.50 m with the thickness of 1.50 m & 0.50 m respectively. In MMLM-3 mineralised zone encountered at the depth of 33.00 m having thickness 1.20 m.

MECL

In Odisha, a G4 level exploration in Ambadala-Sunakhunti area, Rayagada and Kalahandi districts was carried out with the broad objectives to (i) map and demarcate mineralisation & other geological features, (ii) collect samples and analyse them for copper, gold & molybdenum, etc. The study involved mapping of 100.00 sq.km area on 1:12,500 scale with collection of 102 bedrock samples and 6 trench samples along with 228.5 cu.m m excavation and collection of 11 surface channel trench/channel samples. Analysis of samples shows that the block does not have the potential for further exploration.

MOIL

During 2018-19, a total of 10,983 m exploratory drilling involving 36 boreholes in 9 manganese ore mines were carried out. Among these 9 mines, two mines viz, Dongri Buzurg & Chikla manganese mines are situated in district Bhandara & five mines viz, Kandri, Mansar, Gumgaon, Parsoda mines are situated in district Nagpur, Maharashtra State. Two mines viz, Ukwa and Bharweli mines are situated in district Balaghat, Madhya Pradesh. The reported reserves/resources of manganese ore as on 1.4.2019 of all the 12 mines of MOIL were estimated at 89.41 million tonnes. Ukwa (13.78 million tonnes), Bharweli (24.92 million tonnes), Tirodi (0.72 million tonnes), Sitapatore & Sukli (0.12 million tonnes & 0.16 million tonnes), Chikla (4.49 million tonnes), Dongri Buzurg (17.86 million tonnes), Kandri (12.10 million tonnes), Mansar (5.58 million tonnes), Parsoda (0.53 million tonnes), Beldongri (0.15 million tonnes), Old Satuk (0.50 million tonnes), New Satuk (0.02 million tonnes) and Gumgaon (8.5 million tonnes). A total of 20 samples were analysed from Kandri mine.

Rashtriya Ispat Nigam Limited (RINL)

In RINL, Andhra Pradesh, exploration for manganese was carried out over an area of 264.54 ha in Garbham manganese mine, Merakamudidam,

Vizianagaram district. A total of 1,574.00 m core drilling were carried out in 28 boreholes in the potential areas of mining lease. The central and west Garbham area have been identified to be mineralised area. The tentative total resources estimated in the area has been placed at 15 million tonnes. The final resources estimation are in process.

Rare-Earths Elements (REE)

GSI

In Arunachal Pradesh, a preliminary exploration for Neodymium and other Rare-earth Elements (REE) mineralisation in the metasedimentary sequence of Bomdila Group in Laggi Gamlin area, West Siang district, was taken up. A total 4 bands of carbonaceous phyllite having a strike extension of less than 200 m with thickness of 5-20 m were mapped during the traverse. During investigation11.34 line km of Ground Magnetic survey, high magnetic anomaly was noted in north-western part of the block due to presence of the magnetite and haematite. Magnetite yielded high TREE of 17,530 ppm, while Nd ranged from 5.38 - 1,194.5 ppm. The soil samples (30 nos.) developed over carbonaceous phyllite and magnetite -rich rocks yielded TREE from 121.8 - 4,682.53 ppm and Nd concentration between 9 and 547 ppm. Trenching was carried out in the anomalous zone obtained from geophysical survey.

In Andhra Pradesh, a reconnaissance survey for REE and Rare Metal (RM) mineralisation in Tapasikonda-Sitapalli area, East Godavari district was taken up. In the survey area, khondalite, charnockite and migmatite suite of rocks have been found to be intruded by aplites, pegmatites and quartz veins. Graphite and tungsten occur as small pockets and lenses within the graphite gneiss. Disseminations of graphite are noted at places. The old workings for graphite were observed in the Tapasikonda Reserved Forest and NE of Etipalli. Weathered khondalites showing disseminated graphite grains along the foliation intruded with quartz veins in the old workings. Wolframite was observed in a stray quartz vein sample collected from the dump material in the Tapasikonda reserved forest.

Reconnaissance survey for REE and RM occurrences in Nadigadda block of Chittoor & Cuddapah districts was taken up in the earlier explored (2015-16) area in which the total REE values vary from 107.42 ppm to 2,162.4 ppm and 18 composite samples out of 196 show values more than 1,000 ppm. The source rock for REE in the study area is alkali feldspar granite and pegmatite which occur in the southern margin of the study area and have intrusive contact with other granitoids of the area. The main intrusion observed in east of Malapalle extends for about 3 sq. km area. Petrographic study indicates the concentration of REE minerals more in alkali granite and pegmatite. Monazite and allanite are the REE bearing minerals identified. They occur as primary and secondary concentration in both alkali granite and pegmatite. The secondary concentration is observed as fracture filling within quartz grain. In all the samples, the HREE value is less than the LREE value. The total REE values of BRS range from two to 517 ppm, PCS range from six to 943 ppm, SSS range from 19 to 2,448 ppm, PTS range from 25 to 986 ppm and SS range from 235 to 1,043 ppm. These higher REE values are located over biotite granite and biotite granite gneiss, which are rich in pegmatite in the central part of the study area.

In Bihar, the 1.5 sq.km preliminary exploration areas in Belhariya block, Banka district for REE and RM was mapped in detail on 1:2,000 scale along with 300 m of auger drilling at 100 m x 100 m spacing with an average depth of 2.5 m and 52 cu. m of trenching. In most of the trenches, two depositional layers were (L_1 & L_2) identified. The L_1 layer has more concentration of heavy minerals than L_2 layer. Available analytical data of 120 auger soil samples show encouraging values of tREE varying from 120.72 ppm to 1,045.38 ppm with an average of 426.05 ppm (UCC value 146 ppm). Out of 120 samples, 43 A-horizon soil samples analysed showed tREE values ranging from 218.42 ppm to 942.26 ppm, in the 56 B-horizon soil samples analysed, tREE value ranged from 124.57 ppm to 807.75 ppm and in the 21 C-horizon soil samples, tREE ranged from 120.72 ppm to 1045.38 ppm. The critical elements (Nd, Eu, Tb, Dy, Y, Er) concentration in some of the samples showed

higher values, such as Nd between 20.08 ppm and 184.10 ppm (UCC value 27 ppm), Tb from 0.74 ppm to 7.33 ppm (UCC value 0.7 ppm), Dy from 4.51 ppm to 49.86 ppm (UCC value 3.9 ppm), Y between 44 ppm and 131 ppm (UCC value 21 ppm) and Er from 2.58 ppm to 31.48 ppm (UCC value 2.3 ppm). Lithium was seen to be in very high concentration in four borehole samples with the analytical value ranging from 800.70 ppm to 1,064.68 ppm (UCC value 24 ppm) indicating a lithium-rich zone in the Belhariya Block. The exploration was continued from field season 2017-18.

In Gujarat, during reconnaissance survey for REE and RM in Ambala-Rangpur Area, Chhota Udaipur district, an area of 109 sq.km was mapped on 1:12,500 scale and 25 cu.m pitting and trenching were carried out. Skarn zones are developed at the contact of granite and dolomite and marble/ calc silicate rocks. Some of them are amazonite bearing which is the probable host for Rare metal mineralisation in the area. A number of skarn zones are reported in the area and in the skarn zone towards south of Village Ambala, presence of psilomelane is confirmed which hosts Nb-Ca-Mn-Ti-Sb (Sb 45%, Nb_2O_5 3.8%, TiO_2 13.26%, CaO 25%, MnO 8.14%) and also may be romeite. It also hosts parisite, spessartine & andradite varieties of garnet and pyrite along with barite, ilmenite and lead. Analysis of BRS of skarn rock from Bharmadev Dungar showed anomalous HREE values with 902.68 ppm yttrium, 101 ppm erbium, 154 ppm ytterbium and 109 ppm of dysprosium along with Sn, Be and Ta. The sample from Village Chisadiya developed over grey porphyritic granite has analysed 1,233 ppm tREE. The value of tREE in clay fraction is more than sand or silt indicating more REE adsorption in clay. SEM studies show presence of titanomagnetite which hosts monazite along the cleavage, ilmenorutile (Nb-Ta bearing) and monazite. Mineral chemistry (EPMA) of granitoids, skarn rocks, calcsilicate rocks and various types of pegmatites reveals presence of LREE silicates, thorite, monazite, xenotime and Sn-W rich phases. Allanite, magnetite-allanite association, parisite, britholite and fluorine-bearing LREE phosphates are the REE phases identified during EPMA analysis.

Reconnaissance survey for REE and RM in Lagami-Koliyathar area, Chhota Udaipur district was taken up with Large Scale Mapping of 118 sq. km on 1:12,500 scale along with collection of 100 BRS in grid pattern, 20 PCS, 25 cu.m of pitting/ trenching, 50 stream sediments and 59 regolith samples. The SEM study of pegmatite reveals Nb-Ta bearing mineral phase (Nb 73% and Ta 3%) hosted in ilmenite associated with chloritised mica. EPMA study of granite and pegmatite indicates presence of allanite, britholite, parisite as well as thorite associated with allanite, magnetite-allanite association and parisite-britholite association.

A G2 stage REE investigation with detailed mapping on 1:1,000 scale and drilling of 7,550 m to explore the REE was carried out in Ambadongar Carbonatite Complex with the objective to assess the potentiality of REE and RM in carbonatite. Petrography study reveals that the carbonatite is mainly constituted of 80% to 90% calcite whereas apatite, amphibole, pervoskite, zircon and barite occur as minor constituents. The Electron Probe Micro-Analyzer (EPMA) study of core samples indicated the presence of REE associated mineral phases like bastnasite, parasite, synchesite, apatite, fluoro apatite and monazite whereas the RM minerals are mainly associated with Pyrochlore. A total of 43 boreholes were drilled to a cumulative depth of 7,550 m with 125 m to 260 m vertical depth in the northern part of Ambadungar area to assess the potentiality of REE. The analytical results of the core sample show encouraging value (0.3% average grade with 0.25% cut off) for REE and Nb (400 ppm average grade with 200 ppm cutoff). The resource estimation will be taken up after the receipt of all the analytical data.

A reconnaissance survey was taken up for REE/ RM mineralisation with associated tin(Sn) and tungsten(W) mineralisation in Moriyagaon-Amba-Dareri-Sorwa Area in Alirajpur district, Madhya Pradesh and in parts of Chhota Udaipur District, Gujarat. Large Scale Mapping on 1:12,500 scale was carried out in Moriyagaon-Amba-Dareri-Sorwa area in 100 sq. km area with sampling. Allanite, apatite and zircon are the REE bearing phases in the rocks. Maximum value of total REE is 947 ppm associated with the alkali feldspar granite exposed at NW of Village Doveri . A very small mineralised zone of manganese was noticed around Village Moriyagaon . The bedrock samples analysed Mn values of 19.6% and 4.0%.

In Jammu & Kashmir, during reconnaissance survey for strategic and precious minerals, an area of 54 sq.km was mapped on 1:12,500 scale and colluvial samples were collected to evaluate the Rare earth and Rare Metal potential in and around Paddar area, Doda district. EPMA study of 10 sections was also carried out. Sapphire-bearing pegmatite veins within actinolite-tremolite schist are confined in and around Neelam Khan area, which is located at an altitude of 4,700 m (approx.). The rock exposed at Neelam khan showed a range from low to high-grade metamorphic rocks. The pegmatite veins in the rocks are concordant and impersistent as well as discordant. The width of pegmatite vein varies from 10 cm to 1 ft and the length is about 1 km. The corundum/sapphire shreds (06 nos.) of dimension varying from a few mm to 1 cm in size with colour hues from light blue to dark blue were recovered from the Kudi valley during investigation. The maximum value of tREE is 1086 ppm. The analysis of data showed concentration of total LREE to be more than HREE.

In Kerala, Large Scale Mapping over an area 100 sq. km on 1:12,500 scale was carried out during reconnaissance survey for REE in granite around Munnar, Idukki district. Bedrock sampling, pit/ trench sampling, stream sediment sampling and soil (regolith) sampling were adopted for delineating the REE mineralised zones in the study area. A total of 120 bedrock samples, 76 pit/trench samples, 100 stream sediment samples and 101 regolith samples were collected for chemical analysis for delineating the REE mineralised zones in the study area. A total of 28 granite bedrock samples showed total REE (La to Lu) values ranging from 118.20 ppm to 2,152.98 ppm with mean value of 961.40 ppm and 25 regolith samples showed total REE (La to Lu) values ranging from 185.07 ppm to 1,702.96 ppm with mean value of 588.64 ppm.

In Kasaragod district, reconnaissance survey for REE was carried out in syenite and associated laterite in Angadimogar area covering 100 sq.km. Analytical results of 62 bedrock samples showed total REE (La to Lu) values ranging from 58.91 ppm to 3,964.61 ppm and 33 regolith samples showed total REE (La to Lu) values ranging from 65.79 ppm to 1,423.71 ppm.

In Madhya Pradesh, reconnaissance survey for Rare Earth Elements (REE), Rare Metals (RM) mineralisation with associated tin and tungsten mineralisation in Motibar-Jetpur-Eran-Pangura area in Alirajpur district was carried out with large-scale mapping of 100 sq. km on 1:12,500 scale. Result of REE in soil orientation survey showed REE concentration in top soil due to immobility. REE results for 36 BRS samples showed maximum total REE values of 776.8 ppm.

In Betul district, reconnaissance survey for REE and RM mineralisation in parts of Murha-Bhawargarh Fort-Nishana-Chopardhana areas comprised mapping of 200 sq. km area on 1:12,500 scale with collection of 200 bedrock samples, 150 soil samples and 100 Pit and Trench samples (PTS) along with collection of 30 samples each for EPMA and SEM study to identify potential zones of REE and RM mineralisation. SEM-EDS and Electron probe studies (EPMA) showed presence of REE phases which is not in abundance. Xenotime, monazite, Nb-Ta phases were found as inclusions in tourmaline crystals within pegmatite. Allenite, apatite, epidote, titanite, yttrium bearing zircon, plumbopyrochore, choukisite, calcite and garnet mineral phases were found in porphyroblastic gneiss, hornblende-biotite granite and pegmatites. The chemical analyses of 170 bedrock samples showed ÓREE values ranging from 10.64 ppm to 1686.60 ppm. The ÓLREE varied from 9.96 ppm to 1,568.30 ppm and ÓHREE varied from 0.63 ppm to 148.5 ppm. The highest values of ÓREE 1,686.6 ppm and that of ÓREY (REE+Y) were1,964.64 ppm and these were found at north-west of Bhawargarh Fort. Some samples of alkali syenites and hornblende biotite granites from north of Banka, Bhawargarh Fort, south of Pawahari and west of Chapra to south of Pawarjhanda villages also showed >1000 ppm ÓREE. They also contain higher values of yttrium (Y) up to 341 ppm, niobium (Nb) up to 518 ppm, beryllium (Be) from <1 ppm to 1,022 ppm and strontium (Sr) up to 993 ppm. Higher values of lithium (Li) are found in NE-SW trending quartz reef (up to 700 ppm) located in the NW of Village Kantawari, small tourmalinite patch within pegmatite (0.12%) at SW of Village Murha and green microcline bearing pegmatite veins (725 ppm) at extreme west of Village Banka. One quartz-carbonate reef recorded high Rb values of 1,579 ppm. One stream sediment sample (SSS) from extreme west of Village Banka show high ΣREE of 2,148 ppm. At the same locality a soil sample also showed high ΣREE of 2,444 ppm. Majority of soil samples from south of Pawarjhanda and north of Banka villages recorded

moderate to high ΣREE (100.18 ppm to 1,899.66 ppm).

Reconnaissance survey for REE, tungsten, molybdenum and associated mineralisation in Pichor block, Shivpuri district involved mapping of 127 sq. km on 1:12,500 scale, 75 cu. m of trenching, 25 cu. m of pitting and 50 soil samples were collected mostly in grid pattern from favourable location of REE enrichment. Bedrock samples (BRS) collected from lateritic capping around Village Rahi showed Cu values ranging from 185 ppm to 215 ppm and Ni values up to 105 ppm. REE analysis of 50 BRS samples showed total REE as below 300 ppm except a few samples that showed values ranging from 455 to 523 ppm. Maximum total REE value of 523 ppm was observed from alteration zone developed at the contact of quartz reef and medium-grained granite around Village Khurai. In Chhatarpur district, during reconnaissance survey for Rare Metal (Zr-Y-Nb) and REE mineralisation in parts of Bundelkhand Granitoid Complex (BGC) in Basata and Kunwarpura area, Large Scale Mapping of 100 sq. km on 1:12,500 scale along with 50 cu. m pitting & trenching and collection of 100 BRS, 50 PTS and 10 each for petrological, petrochemical, Ore-microscopy and EPMA studies were carried out. Two alkaline dykes of syenitic composition were located, one north of Village Raipura which traced for a length of 50 m with width up to 20 m. Another alkaline body located NNE of Village Kunwarpura measured up to 3 m in width and 30 m in length. Analytical results of alkaline dykes showed encouraging ΣREE values from 522 ppm to 1,314 ppm. The average ΣREE values were 768 ppm. ΣLREE varied from 506-1,285 ppm while ΣHREE varied 12 to 38 ppm. This dyke also showed ΣREE of 456-1310 ppm in 10 Pit and Trench samples (PTS).

In Maharashtra, the preliminary investigation (G3 stage) for locating REE & RM mineralisation in intrusive granite associated with Central India Tectonic Zone (CITZ) in the Dongarla-Mohgaon block of Tumsar area was carried out with Large Scale Mapping over 50 sq. km area, detailed mapping over 2 sq. km and cumulative drilling of 410 m in 35 boreholes. Large tourmaline-bearing pegmatite (800 m x 35 m) near Dongarla area and number of discordant veins of pegmatite having approximate thickness from 1 to 15 m in the Yerli area have also been mapped and studied. REE-bearing mineral phases like monazite, xenotime and zircon have been identified in the petrographic studies of this pegmatite. A total of 35 boreholes were drilled with two boreholes drilled in Dongarla pegmatite and 33 boreholes drilled in secondary loose material. The maximum drilling depth in loose material was 10 m and the minimum 3.5 m. The principal rare earth-bearing minerals observed in petro-mineralogical studies in the heavy concentrate of auger samples have been identified as rare-earth phosphates i.e.,Monazite (Ce, La, Y, Th, PO_4) and Xenotime (YPO_4) along with zircon, garnet, tourmaline and ilmenite. Lithium concentration up to 210 ppm is observed from mica-rich zones of this pegmatite. The highest concentration of TREE of 745 ppm in bedrock sample is found from the weathered pegmatite sample from north of Pachara area along with tungsten value of 448 ppm. Higher values of rubidium, i.e., 0.19% and that of niobium, i.e., 226 ppm were recorded in the pegmatite samples from the southeast of Village Dongarla . The secondary mineralisation is associated with the heavy fractions of alluvial/illuvial material. Out of the 15 samples taken for geochemical analysis, 4 samples have total REE (TREE) between 1.1% and 1.13%, one sample has 2.43% TREE, one sample yielded 3.04% TREE, four sample yielded 0.1% to 0.3 TREE and five samples yielded 0.35% to 0.84 TREE.

In Meghalaya & Assam, a reconnaissance survey for REE in biotite gneiss and granitic rocks of Garbhanga-Jorabat area, Kamrup (Metro) district, Assam and Ri-Bhoi district, Meghalaya, was carried out by mapping 75 sq.km area on 1:12,500 scale . Pitting and trenching of 75 cu.m in grid pattern was done in two blocks of 1.5 sq.km each and also 75 Pit/Trench samples were collected. The chemical analysis results of pitting/trenching samples indicated total REE concentration from 268.901 to 505.72 ppm (Avg. 381.94). BRS samples showed total REE content from 26.55 to 760.89 ppm (average 366.12 ppm).

In Odisha, reconnaissance survey for Columbite-Tantalite and REE in pegmatite was carried out in an area of over 100 sq.km through large-scale mapping on 1:10,000 scale. The petrographic and ore

microscopy studies of pegmatites revealed that microcline and albite are the dominant feldspars with subordinate muscovite and quartz. Accessory minerals viz. garnet, tourmaline, apatite, rutile, zircon, beryl and monazite are also seen in petrographic studies. The REE analysis of a BRS sample (BRS-9) showed total REE value of 1,492.64 ppm and samples BRS-5 and BRS-14 showed the total value of REE as > 500 ppm. The REE analysis of BRS samples (BRS-30 and BRS-07) showed REE (Ce) value of 494.497 ppm and 991.844 ppm. A few channel samples collected from the Bauli Nadi pegmatite body showed total value of REE ranging between 469 ppm and 730 ppm. Soil samples do not show any significant anomaly for REE.

In Rajasthan, during reconnaissance survey for REE mineralisation in and around Borana area, Rajsamand district, an area of 100 sq.km was mapped on 1:12,500 scale. The malachite stains have been seen in quartz veins, etc. A pegmatite body of 700-800 m length and 100-150 m width has been noticed in south-western part of Village Kemuniya . The sparsely dispersed allanite grains have been observed within migmatite gneiss and syenite near Chatrawanmata temple at Borana. A total of 401 bedrock samples have been collected for chemical analysis. The analytical results of a few bedrock samples (BRS) in migmatite gneiss showed that the ÓREE value varies from 1,300 ppm to 3,300 ppm whereas in 2 samples in syenite/alkali feldspar syenite it range from 1,700 to 1,850 ppm. These migmatite gneisses with encouraging ÓREE values have been mapped in and around Kemuniya and Palra villages. The REE potential of the area will be evaluated after receipt of analytical results of all the samples.

Reconnaissance survey for REE and Rare Metals in and around Para-Ugain-Kalera-Devra-Paroli-Johna Silli areas of Bhilwara district involved mapping of 100 sq. km area on 1:12,500 scale. The presence of columbite, tantalite, beryl and tourmaline were reported in some of the pegmatites in the study area which ascertains REE potential of the host rock. Surface indication of base metal mineralisation has also been noticed. Small crystals of apatite and zircon have been observed in pegmatite samples. Analytical results of 108 bedrock samples indicated that tREE value of eight samples had higher value ranging from 1,000 ppm to 1,500 ppm. Three samples analysed showed anomalous value from 2,000 ppm to 2,500 ppm.

A reconnaissance survey was taken up in and around Chappan Ka Pahar, Siwana Ring Complex (SRC), Siwana area, Barmer district. Large-Scale Mapping at 1:12,500 scale covering 100 sq.km area in southern part of SRC was completed. Chemical analysis indicates encouraging values of total REE. As per analytical results of 114 BRS samples showed “REE ranges in different rocks as (i) Plagioclase-rich granite: “REE 0.027%-0.48%. (ii) K-feldspar-rich granite: “REE= 0.017%- 0.51%. (iii) Younger Intrusives “REE= 0.28%-2.03%. (iii) Felsic volcanic “REE = 0.013%-0.041%.

In Bhilwara district, reconnaissance survey for Niobium, Tantalum and REE taken up towards east of Gyangarh, Sandmata Complex involved Large-Scale Mapping of 100 sq. km area on 1:12,500 scale. Analytical results indicated that REE concentrations in granite and granite gneiss ranged from 500 ppm to 1300 ppm. Ce values ranged from 215 ppm to 496 ppm, La values ranged from 19 ppm to 396 ppm, Nd values ranged from 15 ppm to 182 ppm and Y values ranged from 55 ppm to 103 ppm and Nb values ranged from 13 ppm to 66 ppm.

During reconnaissance survey for REE and rare metal mineralisation in Sarnu-Dandali area, Barmer district, an area of 60 sq. km was mapped on 1:12,500 scale. A total of 20 line km of gravity, magnetic and radiometric survey covering 2 sq.km were carried out to understand the behaviour of alkaline rocks and to delineate carbonatite bodies in sand covered area. Carbonatite dyke in Kamthai area showed panther-skin texture. Another carbonatite dyke identified around Chibar Nadi area, was found to be fine-grained, yellow coloured rock. Chemical analysis of 32 BRS samples showed “REE values ranging from 0.019% to 16.5% with LREE more than HREE. Two bedrock samples of carbonatite from Kamthai area yielded 8.98% and 16.5% “REE and carbonatite from south of Sarnu showed very low values (0.06%). Foidite showed 0.13% REE value. In Kamthai area, EPMA study of carbonatite indicated bastnasite, ancylite and parasite as major REE phases while carbonatite from Chibar Nadi area indicated the dominant REE phase as monazite. In alkali feldspar, syenite dominant REE phases included monazite and ferrugosanite (Niobium-bearing phase).

In Tamil Nadu, reconnaissance survey for Rare Metals (RM) and Rare Earth Elements (REE) was

taken up in the southern extension of alkaline carbonatite complex in parts of Mechcheri and Perumbalai taluks, Salem and Dharmapuri Districts. Out of 110 bed-rock samples collected, 15 BRS from carbonatite body showed an average value of REE as 2,447.48 ppm. The total REE value that ranged from 465.46 to 3,941.40 ppm (0.05 to 0.39 %) also includes range of LREE from 438.79 to 3785.33 ppm and range of HREE from 26.67 to 156.06 ppm. BRS (28 nos) collected from carbonated gneiss/calc silicate showed total REE value ranging from 3.76 ppm to 1,759.00 ppm which includes LREE value that ranges from 3.59 to 1,677.50 ppm and HREE value that ranges from 0.17 to 81.49 ppm. BRS (10 nos) collected from pink syenite showed total REE value ranging from 88.19 ppm to 431.28 ppm which also includes LREE value that ranges from 81.55 to 391.51 ppm and HREE value that ranges from 6.64 to 39.77 ppm. BRS (07 nos) of grey syenite showed total REE value ranging from 183.39 ppm to 434.82 ppm which also includes LREE value that ranges from 169.32 to 399.68 ppm and HREE value that ranges from 10.47 to 35.14 ppm. The analytical results of regolith samples (25 no) showed REE value ranging from 101.65 to 970.37 ppm which also includes LREE value that ranges from 88.44 to 934.53 ppm and HREE value that ranges from 13.21 to 35.84 ppm. Colluvial samples (25 nos.) showed REE value ranging from 84.59 to 1,252.02 ppm which also includes LREE value that ranges from 75.60 to 1,185.46 ppm and HREE value that ranges from 9.00 to 66.56 ppm. Analytical results of two samples from pegmatite body (in vicinity of carbonatite) showed anomalous Nb value ranging from 172.44 ppm to 356.27 ppm, Ta value ranging from 1.34 ppm to 17.46 ppm and Total REE value ranging from 741 to 2,301 ppm with Ce as most abundant among all the REEs.

Reconnaissance survey for REE, RM and associated mineralisation was taken up in Thiruvallur and Vellore districts. The investigation area forms a part of Chitoor terrain of northern Tamil Nadu. To the north of Palar lineament lies the granite gneiss terrain which is traversed by number of dolerite dykes whereas to the south of it, the area becomes high-grade granulite terrain. Banded magnetite quartzite is present in the study area as patches within granitoids. Seven small syenite bodies are identified and mapped which are massive, coarse to medium-grained, pink in colour and occur as small bouldery outcrops. Amphibolite is also found to be exposed at a very shallow level near Jambukulam. Syenites are massive, brick red to pink in colour and consist of orthoclase, plagioclase and very small amount of quartz and specularite.

In Telangana, a reconnaissance survey for REE mineralisation in granitoids of Peninsular Gneissic Complex around Chandampet, Kalwakurthy area in parts of Nagarkurnool and Nalgonda districts was taken up by covering an area of 100 sq. km by Large-Scale Mapping on 1:12,500 scale. SEM studies confirmed presence of REE-bearing trace minerals like sphene, apatite, epidote etc. in the granites and pegmatites of the area.

In Uttar Pradesh, preliminary exploration for REE was carried out with an objective to assess potentiality of REE mineralisation in Nawatola-Laband area, Sonbhadra district. An area of 2 sq. km was mapped on 1:1,000 scale (DM) along with pitting-trenching of 50 cu.m. From the analytical results of samples it has been observed that out of 110 samples (Channel, Pitting/ Trenching and soil), 19 samples have yielded REE values greater than 750 ppm and 6 samples showed values greater than 1,000 ppm. Out of 10 soil samples, 5 samples yielded REE value more than 750 ppm and it varied from 412.77 to 2,729.23 ppm with an average value of 903.56 ppm. Out of 10 pit samples, six samples showed values greater than 750 ppm. REE enrichment is shown by magnetite-bearing K-feldspar granite veins intrusive into K-feldspar porphyroclast-rich granite gneiss rock. The study will continue from 2018-19.

In West Bengal, during reconnaissance survey, Large-Scale Mapping of 101 sq.km on 1:12,500 scale and detailed mapping of 2.01 sq.km on 1:2,000 scale were carried out in and around Kalapathar-Lakshmanpur area, Purulia district. Besides, 105 BRS, 50 PTS, 50 SS and 10 PCS samples were collected from the study area for chemical analysis. In Kalapathar area, numerous pegmatite and quartz veins are intruded within porphyroclastic granite gneiss with length ranging from 3 cm to 20 cm and have high specific gravity. Presence of barite mineralisation is established by field study as well as microscopic study. A few of these veins have high total REE concentration, i.e., 8.35%, 2.37% and 1.08% (La, Nd and Ce content are very high, LREE>HREE). Petrographic study of these veins showed presence of REE-bearing mineral. Abundance of xenotime, monazite, apatite, allanite

and sphene have been noted. During detailed mapping, these veins have found to be intrusive within PGG around Raghudih area. Presence of significantly high Ni (463 ppm) and Cr (761 ppm) content was recorded from olivine-bearing gabbro around Kalapathar area.

Reconnaissance survey for REE and RM in Baishyakuli Sindurpur area, Purulia district involved mapping of 100 sq.km area on 1:1,2500 scale and 2 sq. km area on 1:2,000 scale. Analytical results of a sample of amphibole-bearing Tilabani granite gneiss showed presence of 1,379.64 ppm ÓREE which include 329 ppm La, 562.5 ppm Ce and 248.5 ppm Nd. Another sample near Bara Panjania showed 906.4 ppm ÓREE 190.3 ppm La, 396.4 ppm Ce and 157 ppm Nd. Encouraging values have also been noted in soil samples. A soil sample from west of Asanbani showed 2,292.7 ppm ÓREE that include 537.3 ppm La, 1,079.7 ppm Ce and 384.4 ppm Nd. Another soil sample from the area showed 998.2 ppm ÓREE which include 246.6 ppm La, 441.5 ppm Ce and 175.8 ppm Nd. Petrological study showed the main REE-bearing minerals to be allanite, apatite, monazite and zircon. Surface manifestations of sulphide mineralisation are present in the form of fresh sulphide like pyrite within amphibolite and chalcopyrite within granitehave been observed. Slags have also been noticed around Tilabani hill with presence of haematite and magnetite.

STATE DIRECTORATES

Directorate Mines & Geology, Rajasthan

During 2018-19, regional mineral survey in Sodha ki Dhani, Bambdi Nadi and Sevron Kin Dhani, Sindhari tehsil, Barmer district, Rajasthan, was taken up with an objective to search for Rare-earth Elements. An area of 20 sq.km on 1:10,000 scale, 2.0 sq.km on 1:4,000 scale was covered and 17 samples were collected during survey. Two carbonatite dykes were observed in and around Bambdi Nadi, Sevron kin Dhani. One carbonatite dyke is exposed up to 30 m in length and 1.0 to 2.0 m in width. The other carbonatite dyke is 42.0 m in length and 2.70 m in width. Earlier three carbonatite samples have indicated REE values near Bambodi nadi, Sodha Ki Dhani in Baytu tehsil. The REE value ranges from 168 ppm to 470 ppm, in this HREE ranges from 0.02% to 0.05% and yttrium ranges from 27.69 ppm to 51.10 ppm. The area seems to be an anomalous zone having high values of REE. Investigation will continue. In Sindhari tehsil, an area of 20.0 sq.km was mapped on 1:10,000 scale in search of REE near Village Sodha ki Dhani, Bambdi and Savron ki Dhani area in Barmer district. Exploration will continue in next field session.

Strategic Metals

Tin

GSI

In Meghalaya, reconnaissance survey for tin mineralisation was taken up in Lyngkhoi-Sohiong block, West Khashi hills district. An area of 50 sq.km was mapped on 1:12,500 scale to identify the lithological variations and the intrusive acidic veins. In the absence of any prominent pegmatite veins, only the quartz veins were sampled to find out possible tin mineralisation. Chip & channel samples were collected from bedrock (BRS) and pit/trench samples (PTS) were collected from vein quartz to study the possible tin mineralisation in the area. Stream sediment samples were also collected to study the heavy mineral assemblage in the terrigeneous material. In stream sediment samples, Sn concentration was seen to vary from 4 to 20 ppm, and the maximum of 91 ppm was noticed in only one sample. Sn concentration in vein quartz (BRS/PTS) vary from less than 1 to 23 ppm which does not seem encouraging in context of tin mineralisation. The study will continue in field season 2019-20.

MECL

MECL carried out a G4 level exploration for tin mineralisation in Pihra block of Giridih & Koderma districts, Jharkhand. Remote sensing study of 100.00 sqkm was carried out and later the area was mapped on 1:12,500 scale. A total of 362 samples were collected for different studies/ analysis. It include 87 nos of sediments samples for Sn, Nb & Ta,; 50 bedrock samples for REE, U & Cs and 68 bedrock samples for Li analysis.

Tungsten

GSI

In Assam, during reconnaissance survey for tungsten in granite gneiss and associated

granitoids in Inglengagaon-Dokmuka-Baghpani area, Karbi Anglong district, an Aerial reconnaissance survey was carried out in the area. An area of 50 sq. km was mapped on 1:12,500 scale. Based on spatial association of alterations and muscovite-tourmaline-bearing pegmatite veins, two possible zones which might be favorable for tungsten mineralisation have been delineated. Analytical results of monzogranite showed elevated values of total REE in the range from 664.29 to 933.05 ppm while W ranged from 0.5 to 11 ppm. The elevated values are from samples collected from greisens vein and tourmaline-bearing pegmatite vein. Sn value ranged from 1.01 to 52 ppm while Mo ranged from 0.5 to 20.6 ppm.

During reconnaissance survey for tungsten mineralisation in and around Khetri area, Kamrup (metro) district, an area of 90 sq. km was mapped on 1:12,500 scale. The hydrothermally altered quartz veins at Barbitli showed higher values of W (216 & 238 ppm), Sn (16.5 & 15.8 ppm) and Mo (8.28 & 11.94 ppm). The quartz vein sample at the contact between migmatite and pelitic schist near Sametapathar showed 463.8 ppm W with 12.4 ppm of Mo and 8.45 ppm of Sn. The miarolitic pegmatites from Helagog showed 5.19 to 96.09 ppm Sn and 2.89 to 10.88 ppm Mo. Garnetiferous pegmatite at 1.2 km NW of Gumaria indicated Sn value of 28.98 ppm and Mo value of 15.49 ppm.

In Maharashtra, a reconnaissance survey for locating tungsten and associated mineralisation within the intrusive granite and associated pegmatites of Sausar Mobile Belt was taken up in and around Lodhatola–Garra area, Nagpur district. The exploration work comprised detailed geological mapping of 1.5 sq. km area on 1:2,000 scale in different blocks, i.e., Dolara (0.4 sq.km), Chawari (0.6 sq. km) and Garra (0.5 sq. km). During mapping, the major litho units mapped in Dolara and Chawari Detailed Mapping block are the magnetite-tourmaline bearing quartz-mica-rich vein within the dolomitic marble. The quartz-mica-rich vein ranges in thickness from a few metres to 30 m with length of approx. 400 m in Dolara block and approx. 900 m in Chawari block. At places, small pegmatites and quartz veins are also noticed. Besides, 75 bedrock samples were collected from Dolara, Chawari and Garra block by both grab and channel sampling along with Pit/Trench samples 50. Chemical results of 75 bedrock samples indicated poor tungsten values ranging from 0.54 to 19.05 ppm except for one sample that showed 85 ppm with low tin values of 0.39 to 9.28 ppm.

The reconnaissance survey for tungsten and associated mineralisation in and around Chandankheda and Parodhi area, Chandrapur district, comprised Large- Scale Mapping over an area of 50 sq. km on 1:12,500 scale and detailed mapping on 1:2,000 scale. One scout borehole of 145 m was drilled to delineate the mineral potential zone for tungsten in the area. A prominent quartz reef was seen in the mapped area. Iron staining is common in the quartz reef. Silicification was noticed along the strike of the quartz reef. About 50 cu.m pitting & trenching and sampling were carried out to delineate the depth persistence and the continuity of the brecciated quartz vein and granite gneiss, respectively. Channel sampling each of 50 cm length was also collected. The desired brecciated quartz vein intersected at 54.40 m depth continued up to 99.20 m in the borehole. Out of 30 samples, 15 samples were analysed and highest tungsten value reported was 2.59 ppm. During EPMA study, 10 micron size gold and silver were observed. In SEM study, pyrite magnetite and one REE phase monazite were identified in chlorite core samples.

In Tamil Nadu, reconnaissance survey for tungsten and associated mineralisation in Kambalipatti–Rayarpatti– Rajanampatti areas of Melur taluk, Madurai district involved Large-Scale Mapping of 100 sq. km area on 1:12,500 scale and detailed mapping of 1.5 sq. km on 1:1,000 scale. To identify the mineralised zone in the preliminary stage, survey was carried out with the help of short wavelength ultraviolet ray. A total of 50 cu.m of pitting and trenching was carried out to establish the strike continuity. A total of six calc granulite bands I, II, III, IV, V and VI of cumulative strike length 11 km, 14 km, 3.5 km, 5 km, 3.5 km and 1 km with average width of 0.5 km, 0.6 km, 100 m, 150 m, 0.5 km and 0.5 km, rescpectively were delineated in the study area. Four prominent mineralised zones, namely, Pulipatti-Karuppukoil, Kanmaypatti-Parakkudi, Rayarpatti-Vanjinagaram and Kambilipatti areas have been identified for

scheelite mineralisation. The scheelite occurs within calc granulite as sporadic, fine specks, dissemination and thin veinlets. In Pulipatti-Karuppukoil, Kanmaypatti-Parakkudi, Rayarpatti-Vanjinagaram and Kambilipatti areas, the maximum W value recorded is 331.79 ppm, 769.96 ppm, 1,000 ppm and 704 ppm, respectively. All the samples collected from other areas analysed W value below 100 ppm. One sample from Rayarpatti area recorded Sn value as 547.77 ppm. Concentrations of WO_3 and CaO vary from 79.2 to 80.7% and 19.9 to 20.4%, respectively.

A G-4 stage investigation that was taken up in and around Melur, Terkutteru, Muthuvelpatti, Kulanipatti, Kidaripatti, Etimangalam, Arittapatti, Vallalappatti, Sillippyapatti, Chettiyarpatti, Nayakkarpatti areas of Melur taluk, Madurai district comprised Large-Scale Mapping of 100 sq. km on 1:12,500 scale, pitting and trenching for 50 cu.m and collection of 50 PTS samples to assess the tungsten mineralisation in soil covered calc-granulite area. Night traverses using UV lamp to identify scheelite mineralisation were carried out. Tungsten mineralisation in the area is in the form of scheelite ($CaWO_4$). Analytical results show that 10 BRS sample have >200 ppm of W with highest value recorded as 966 ppm. Apart from that 50 trench samples were collected, 02 PTS samples showed >200 ppm of W with highest value indicated as 609 ppm. The Kulanipatti band and Muthuvelpatti band showed indication of mineralisation particularly one sample from SE part of Kulanipatti band reported 966 ppm of W value in chemical analysis.

In West Bengal, a reconnaissance survey was taken up to trace the extension of tungsten mineralisation around Chhedapathar area, Bankura district. A total of 100 sq. km were mapped on 1:12,500 scale and 100 cu.m pitting and trenching work was also carried out. Tungsten mineralisation of the area is confined within the quartz veins that traverse the metapelitic rocks. Second generation veins are of three different varieties viz. (i) vitreous, fractured and devoid of any mineralisation, (ii) grey to white massive, slightly cherty and at places contains haematite, specularite, goethite and at places wolframite, and (iii) smoky grey, cherty, fractured and brecciated and which contains wolframite, hematite, specularite and chalcopyrite. Tungsten mineralisation is mainly confined within large second generation veins of last two varieties.

Vanadium

GSI

In Arunachal Pradesh, preliminary exploration for vanadium and associated base metal and gold mineralisation was carried out in the metasedimentary sequence of Bomdila group in Depo area, Papum Pare district. Detailed mapping of 1 sq. km. on 1:2,000 scale along with sampling and drilling of 58 m was taken up. A total of 58 m drilling were completed so far. Chemical analysis results of 03 bedrock samples from Band-1 yielded 127 ppm to 2,264 ppm of V. About 10 composite samples of 1 m length yielded 1,717 ppm to 3,296 ppm vanadium with an average of 2,485 ppm. Trench sample of another band of carbonaceous phyllite yielded 1,852 ppm to 3,850 ppm vanadium with an average of 2,477 ppm.

Reconnaissance survey for vanadium and associated minerals in Deed area, Lower Subansiri district, comprised large-scale mapping of 50 sq.km area on 1:12,500 scale with 50 cu.m of Pitting/Trenching. The survey was carried out to evaluate the potential of vanadium mineralisation in the area. Chemical analyses of BRS samples (77 nos) from carbonaceous phyllite assayed vanadium values ranging from 612 ppm to 5,318 ppm. Trench samples assayed values of vanadium ranging from 700 ppm to 1,800 ppm. Channel sampling (76 nos) which was carried out in order to delineate zone wise potential of carbonaceous phyllite, assayed vanadium values ranging from 689 ppm to 5,107 ppm. Gold values from more than 25 BRS samples of carbonaceous phyllite recorded values more than 150 ppb reaching up to 198 ppb. Fixed carbon analysis for 76 of channel samples of carbonaceous phyllite showed 7 to 36% of fixed carbon.

In Bihar, reconnaissance survey for strategic minerals (Ti, V, Ga) in laterite exposed in and around Adhaura area, Kaimur district involved Large-Scale Mapping of 118 sq.km area on 1:12,500 scale, pitting/ trenching and collection of BRS, PCS & stream sediment samples for heavy mineral studies. Three major lateritic bodies with sizeable dimensions have

been delineated in the area east of Karar, northwest of Dahar and west of Gudari villages, respectively. All these laterite bodies were found to be extending in the directions of prominent lineament (NW-SE, NE-SW and N-S). Analytical results of 98 BRS samples showed content of TiO_2 varying from 0.92 to 16.62%, V from 12 to 1,189 ppm; Ga from 6 to 91 ppm and tREE from 124.06 to 433.32 ppm while 23 PTS sample showed variations of TiO_2, V and Ga from 2.32 to 10.53%, 55 to 674 ppm, and 17 to 57 ppm, respectively.

In Meghalaya, a reconnaissance survey for titaniferous-vanadiferous–magnetite around Uming area, West Jaintia Hills district was taken up. A total area of 50 sq. km was mapped on 1:12,500 scale to evaluate the potential of titaniferous vanadiferous magnetite bodies in the area. Chemical analysis of samples collected from various lithunits show values of TiO_2 ranging from 16.4 to 17.58% and vanadium from 92 to 9,201 ppm. A total of 0.4 L km of magnetic survey only were completed owing to undulating terrain and inaccessibility. About 39.0 cu.m of shallow pitting & trenching was done in order to check the continuity of the magnetite body.

Molybdenum

GSI

In Chhattisgarh, reconnaissance survey for molybdenum, tungsten and associated base metal mineralisation was taken up in Shankargarh block, eastern extension of Burhabagicha sulphide zone, Balrampur-Ramanujganj district. During survey Large- Scale Mapping for 100 sq. km area on 1:12,500 scale along with collection of 300 bedrock and 30 petro-chemical samples was carried out. In the chert bands of calc-silicate rock near Village Bhadar, discrete small grain of scheelite was observed under UV light during night traverses. In meta-volcanic and meta-sedimentary rocks, rich dissemination of sulphide minerals, such as, pyrite, sphalerite, pyrrhotite, covellite, etc. were noticed in petrographic studies. The chemical analysis of bedrock samples does not show molybdenum or tungsten mineralisation. ÓREE values for 40 bedrock samples range from 47.50 ppm to 512.98 ppm. Besides, in 129 bedrock samples the values of Cu varies from <10 ppm to 250 ppm, Pb range from <10 ppm to 80 ppm and Zn range from 10 ppm to 500 ppm. Gold values of 169 bedrock samples are below detection limit. The arsenic values of 40 bedrock samples range from <1 ppm to 50 ppm.

Nickel

GSI

In Chhattisgarh, during reconnaissance survey for Ni, Cr and associated PGE mineralisation in Bhalukona-Jamnidih block, Mahasamund district, an area of 100 sq. km was systematically mapped on 1:12,500 scale and a total of five pyroxenite and 3 anorthositic gabbro bands were demarcated. The length of these bodies varies from 50 m to 6 km (appx.) and width between <25 m and about 200 m. The analytical results of BRS samples from meta-ultramafites, gabbro and pyroxenite have yielded anomalous values of Ni, Cr and Cu. Bedrock samples from Bhalukona area indicated Ni values up to 2,300 ppm, Cr values up to 2,700 ppm and Cu values up to 1,500 ppm whereas the analysis for gold has yielded values up to 1.9 ppm in rhyolite near Chapiya area. The pyroxenite body in Chiprikona area extends to a strike length of 400 m with 50 m in width and on analysis yielded high Pd (1,174 ppb), Pt (241 ppb) and Ni (0.16%) values. Ore microscopic study revealed the presence of pyrrhotite, pentaldite, chalcopyrite and magnetite in silicate gangue of uralitised pyroxenite.

In Jharkhand, reconnaissance survey was taken up for Ni, Cr and PGE mineralisation in Kanderberiya-Dangardih area, East Singhbhum district. During the course of the investigation, mafic and ultramafic bodies were found as intrusion in Dalma Group of rocks and these were targeted for Ni, Cr and PGE mineralisation. Talc-tremolite-chlorite schist (TTCS) has been traced at southern part of the mapped area for a strike length of 7.5 km with maximum width of 500 m. Large-Scale Mapping of 100 sq. km. area on 1:12,500 scale was carried out along with 100 cu.m of pitting and trenching. A Total of 102 bedrock samples (BRS), 100 pitting & trenching samples (PTS), 50 stream sediment samples (SSS), 27 petrological samples (PS), 15 petrochemical samples (PCS) and 10 samples for electron probe micro analyser (EPMA) were collected. Out of 267 samples, results were received for 85 BRS and 32 PTS. Based on the part chemical analysis result of BRS and PTS, the maximum value of Cr was recorded as 3,011 ppm, Ni 1,374 ppm, Cu 1,339 ppm and Zn as 307 ppm. All the values obtained from TTCS of Lower Dalma Formation showed copper mineralisation near Village Haludbani.

In Karnataka, a reconnaissance survey for Ni-PGE and gold between Holalkere and Doddaghatta was carried out in Jaychamrajpura schist belt, Tumakuru district. The investigation comprised

Detail geological mapping of about 1.8 sq. km and contouring of 2.5 sq. km on 1:2,000 scale along with 61 cu.m of trenching and collection of 47 samples. Geophysical magnetic survey of 61 L km and IP/resistivity survey of 37 L km survey were also carried out. A suspected chromite layer (50 cm) has been noticed in schistose serpentinite. Amphibolite from the north-eastern part analysed a total PGE of 345 ppb. The contact zone was also sampled. Arsenopyrite, chalcopyrite and pyrrhotite were identified in EPMA.

In Tumakuru district, a reconnaissance survey for Ni-PGE and gold mineralisation between Rampura and Gollarahatti areas was taken up. A total of 3 trenches were excavated across the contact between mafic-ultramafic variants. PGE concentration of 3 stream sediment samples collected from Ist order streams indicated PGE concentration of 1230 to 1333 ppb (>1000 ppb), while 02 samples showed values ranging from 109 to 153 ppb (>100 ppb), streams flowing through serpentinite regions around NE of Village Gollarahatti favoured presence of PGE mineralisation. Presence of sulphide minerals, namely, pyrite, pentlandite and pyrrhotite was noticed during petrographic study. EPMA study reported a single grain of sperrylite ($PtAs_2$; ~1µm) associated with chrome-magnetite in serpentinite.

The reconnaissance survey for Ni-Cu-PGE-Au in the mafic-ultramafic bodies of Hadanur-Tagadur belt, Mandya district, involved Large-Scale Mapping on 1:12,500 scale with bedrock, stream sediment and soil sampling. A total of 100 sq.km area were mapped. South of Sudugadanakoppalu, about 5 m wide chromitite bands were traced within talc-serpentine schist. Intrusive olivine gabbro of Chokkanahalli, meta-orthopyroxenite of Ragimudhanahalli and meta-clinopyroxenite from Doddabhoganahalli contain chalcopyrite, pentlantite, pyrrhotite and pyrite mineralisation as stringers & dissemination. Near Hadanur, quartz veins in amphibolite have been reported to contain significant chalcopyrite. Gold nugget was recovered from heavy mineral concentrates from SE of Illenahalli. EPMA of sulphide and PGE phases will be carried out. A total of 12 stream sediment samples showed significant Pd content up to 135 ppb as, compared to bedrock and trench samples. Analytical results are awaited.

In Rajasthan, reconnaissance survey for Ni and associated PGE mineralisation in Rikhabdev ultramafic rocks of Rohanwara-Matugamra-Amarpura area, Udaipur/Dungarpur districts involved Large Scale Mapping of 100 sq. km and 700 sq. km ASTER image processing. The main host rock for Ni, Cr and PGE in this area is serpentinite. A major NW-SE trending serpentinite unit has been observed around Khemaru area having a strike length of about 5 km and the width of which varies from 500 m to 1.5 km. Around 10 small, isolated serpentinite units have been observed around Gora Moraya, north of Pandiawara, Rohanwara, west of Depur, north of Redla, north of Kherwada and around Methali area. Towards south of Khemaru, oxidised zone has been recorded within serpentinite along the contact of phyllite. The thickness of the zone which varied from 1 to 2 m extended for a strike length of about 15 to 20 m. Towards west of Depur area, malachite stains were observed in talc-chlorite-schist and the thickness of that zone varied from 2 to 3 m and the strike length extended to about 30 to 35 m. Chemical analysis result of 40 bedrock samples indicated Ni, Cr and Co value ranging from 170 ppm to 0.64%, 370 ppm to 1.16 % and 15 ppm to 250 ppm in serpentines, respectively.

Preliminary exploration for Ni and precious metals mineralisation was carried out around Dunkar-Rupeli area, in parts of Bidasar Ophiolite Suite, Churu district. A total of 5 boreholes were drillied to a cumulative depth of 1,000 m with depth ranging from 150 m to 240 m. To delineate different serpentinite bodies and demarcate source rock for Ni anomaly an area of 2 sq. km was mapped on 1:2,000 scale. A total of 460 core samples were collected for chemical analysis. Analytical values of a total 184 core samples up to the depth of 144.0 m of serpentinite in one borehole have been analysed for Ni and values showed variation from 170 ppm to 0.23% within serpentinite. The rest of the chemical results are awaited.

In Pratapgarh district, preliminary exploration for nickel and associated mineralisation in Ambav area was carried out. During the course of the investigation, detailed mapping of 1.0 sq. km area on 1: 2,000 scale along with 768 m drilling was carried out. An old working of 120 m strike length with maximum width of 20 m was exposed in the study area. The samples for EPMA analysis collected from

the brecciated and limonitised mineralised zones showed that the mineralisation is in alloy form, i.e., Cu-Ni-Sn-Au & Ni-Zn-Pb-S. In the Cu-Ni-Sn-Au alloy, Ni showed 71.82% element content whereas in Ni-Zn-Pb-S alloy, Zn showed 71.32% element content.

In Tamil Nadu, the reconnaissance survey for Ni-Cu-PGE in Arumanallur-Kiripparai area, in Kanyakumari district was taken up with an objective to delineate the potential zones of Ni-Cu-PGE mineralisation and to bring out the nature and control of mineralisation in the area. During investigation, an area of 100 sq.km was mapped on 1: 12,500 scale and 100 bedrock samples were collected to ascertain the potentiality of Ni-Cu-PGE mineralisation. SEM-EDX study revealed the presence of sulphide phases like pyrrotite, chalcopyrite, pyrite and sphalerite and the oxides like monazite, ilmenite, barite and tungsten. The Platinum value was found to range from <5 to 64 ppb while Palladium value ranged from <5 to 8 ppb ; the trace element copper (Cu) ranged from 20 – 180 ppm and nickel (Ni) varied from 23 – 133 ppm.

MARINE & COASTAL SURVEY GSI

Detailed exploration for polymetals (Co, REE, Ni and Zn etc.) in the Fe-Mn crust/nodules in the southern part of West Sewell Ridge and regional exploration for Fe-Mn crust/nodules in the Southern part of the Sewell Rise, Andaman Sea involving systematic sampling at 2 km × 2 km grid on West Sewell Ridge (WSR) covering an area of 160 sq. km was carried out. Nodule occurrence was noticed at water depths from 600 m to 1100 m on the western flank and at the summit region of the WSR. The colour of the nodules collected from WSR was black to brownish black to pitch black with botryoidal to granular nature. From the preliminary analysis of the nodule occurrences, a potential area of 94 sq.km has been delineated for detailed exploration over WSR while an area of 176 sq. km has been demarcated for further close grid sampling over Sewell Rise. In the exploration point of view, encouraging results of high metal values, such as, REE, Co, Ni, Zn and Li have been reported in the nodules from WSR and Sewell Rise.

Preliminary investigation for hydrothermal mineral deposits in the southern part of Andaman Accretionary Prism (AAP), Bay of Bengal, was carried out. Around 13 potential zones/blocks were identified. Grab samples were mainly collected from the top of the ridges. Core samples were collected from the valleys and basins. Geochemical analysis of the samples indicates rampant hydrothermal activity as evidenced by the hydrothermal nature of Fe-Mn nodules in the south and hydrothermal alteration of the samples from the north of the study area.

Evaluation of placer minerals resource of the territorial waters off Chilka, Odisha was taken-up to assess the heavy mineral concentration in closed grid vibro-coring (1 km × 1 km). An area of 55 sq. km was covered and a total of 94 lkm bathymetry survey was carried out. A total of 66 core samples were collected with core length varying from 0.68 m to 4 m with an average core length of about 2.10 m. Heavy mineral weight percentage varies from 0.3 to 2.1% and is not encouraging for placer mineral resource evaluation.

Evaluation of placer minerals resource of the territorial waters, off Harchandi, Odisha involved an area of 48 sq.km with geological sampling grid of 1 km x 1 km. A total of 65 vibrocore samples were collected. Core length of the samples varies from 0.18 m to 3.24 m with an average core length of 0.86 m. From the detailed heavy mineral studies, bulk total heavy mineral content off Harchandi area varies from 2.5 to 9.45% with an average HM content of 4.65%. Economic placer minerals identified are ilmenite, garnet, sillimanite, zircon, monazite and rutile.

A total of 1,590 sq. km was surveyed mainly by sampling and swath bathymetry for searching phosphorite in the continental shelf area off Chengalpattu, Tamil Nadu. The sampling was carried out in 5 km × 5 km grid by deploying grab, gravity corer, vibro corer and spade corer and a total of 94 core samples were collected to assess the resource potential of phosphorite. The samples with phosphorite content are restricted to 150 to 220 m water depth. The phosphatic materials mainly occur on the seabed surface as concretions, nodules, xenophora studs and as replacements. P_2O_5 content in bulk samples was found to range from 0.50 to 2.06% and 8.4 to nearly 15% in the concretions/ nodules.

The study of phosphorite was taken up in the Continental Shelf off Point Calimere, Tamil Nadu Coast. The cruise was taken up to assess the potential of phosphorite in the east coast margin of India. During evaluation, an area of 1,560 sq. km was covered with 1,500 l km of gravity survey and

collection of 09 vibro cores, 18 gravity cores, 44 box cores and 10 grab samples. The continental shelf off Point Calimere has a maximum width of 32 km in the north. Surface and subsurface sediments showed the presence of glauconite sand and phosphatic materials. Phosphatic material from the study area consist of concretions, nodules, pellets, peloids and skeletal debris and occurs in association with sand, silt and abundant calcareous material which are mainly confined to the shallower water depths (149-278 mts) and are concentrated in western part of study area at 100-300 m water depths. A very strong positive correlation is observed between the occurrence of phosphatic material and glauconitic sand concentration in the sediment.

Preliminary assessment of lime mud in the continental margin off Maharashtra (Block-VI) was taken up to determine the distribution of lime mud, its nature, quality and quantity in the area. Bathymetry, sub-bottom profiling, gravity and magnetic surveys along with sediment sample collection with gravity corer, vibro corer and piston corer were carried out over an area of 12,060 sq. km. An area of 991 sq.km was earmarked for resource calculation and the thickness of lime mud varies from <13 m to >39 m. The resource calculated from the area is 7,212 million tonnes under validated category and 6,658 million tonnes under inferred category.

An area of 6,000 sq. km was surveyed for Mn-Fe nodules off Lakshadweep Islands. During search for Mn-Fe nodule, an area of 6,000 sq.km was surveyed. Geophysical survey confirmed the presence of 1000–2000 m thickness of sediments in the area. Gravity core of a length of 4.62 m collected from water depth of 4,492 m revealed two lithological units, calcareous ooze and silt. Terrigenous material consists of Fe-Mn micro nodule and grey coloured rock aggregates.

To evaluate placer mineral resource, an area of 50 sq. km off Baruva - Borivanka, Andhra Pradesh Coast was covered by 65l km bathymetry and 66 vibrocore samples at a grid of 1 km x 1 km within the water depth ranges from 18.2 m up to 48.5 m. The survey area is characterized by sand which varies from fine sand to very coarse sand in the surface and ranges from clayey sand to coarse sand in the bottom of vibrocore samples. Heavy mineral concentration varies from 0.32 wt% to 20.73 wt% with an average concentration of 7.93 wt%.

A Preliminary search and study of placer mineral distribution was taken up in the seabed around an area of 69 sq.km falling within 3 m to 30 m water depth off Alang in the Gulf of Khambhat, Gujarat. Area has been investigated with 90 lkm of bathymetric survey and collection of 41 vibro cores and 31 grab samples. The heavy mineral analysis of the seabed sediment sample, indicate that the weight percentage of total heavy minerals vary from 3.4 to 22.6 wt% with an average of 12.5 wt%. Grain mount studies of heavy minerals showed presence of magnetite and ilmenite with non-opaque minerals.

Preliminary search of heavy minerals placer was taken-up to cover an area of 75 sq.km within the water depths of 9.60 to 43.10 m in the surface sediments off Mithi Virdi, Gujarat (Block-3). A total of 90 km of Bathymetry was carried out and a total of 80 sediment samples were collected. Bathymetric data shows presence of channel in the western and central part of survey area, depths from 29.0 m to 41.0 m and shallow patches in the eastern part. The surface sediment of the area is dominant by brownish/ greyish medium to very fine sand and sub-surface sediment is greyish fine to very fine sand with clay.

Preliminary search of heavy minerals placers in the surface sediments off Bhavnagar, Gujarat (Block-5) was taken up to search and study placer mineral distribution in the seabed around an area of 75 sq. km falling within 9.5 m to 61.7 m water depth off Bhavnagar, Gujarat in the Gulf of Khambhat. A total of 155 lkm of bathymetric survey indicate that the seafloor off Bhavnagar, Gujarat to be undulating with channels and sand ridges of tidal regime. Sediment sampling was carried out in 1 x 1 km grid pattern and virbo cores (15), grab samples (69) and one gravity core sample within the water depths of 9.5 m to 61.7 m were collected. Sediments of medium to fine sand, fine to very fine sand, silty sand, sandy silt were observed to consist of heavy minerals and devoid of shells & shell fragments. Studies are in progress.

Preliminary search of heavy mineral placer in the surface sediments off Hathab, Gujarat, was taken up over an area of 75 sq. km (Block-VI) in 1 x 1 km grid, off Khambhat. A total of 157 lkm bathymetric survey was carried out and 90 grab samples within water depths of 11 m and 56 m were collected. The sand sediments contain considerable amount of heavies, mostly in finer fraction with total Heavy Mineral content varying from 2 to 12%. The heavy mineral assemblage in

the sediment includes ilmenite, magnetite, rutile, sillimanite, pyroxenes, amphiboles, epidote, etc.

Evaluation of placer mineral and sand resources off Nethravati river mouth, beyond TW of India, Karnataka was taken up. An area of 250 sq. km in the middle shelf off Nethravati river mouth was covered to evaluate heavy minerals and sand resource potential. A total of 273 lkm of bathymetric survey were carried out and these revealed the presence of discontinuous ridge along the western part of the investigation area. The total heavy mineral concentration of seabed in the surface was not encouraging.

During evaluation of placer mineral resource in the shelf area off Porto Nova, Tamil Nadu, a total of 60 sq. km area were covered for heavy mineral and sand resources estimation. A total 80 vibro core samples have been collected. The heavy minerals found in the surveyed area were sillimanite, ilmenite, garnet, mica, leucoxene, kyanite, zircon, monazite and rutile. The surface distribution values for CaO and $CaCO_3$ were found to vary from 3.59% to 12.19% and 5.10% to 19.45%, respectively with higher value towards southern side of the area.

Platinium Group of Metals (PGM)

GSI

In Kerala, a preliminary exploration (G3) was taken up in Elaichivazhi block, Attapadi Valley, Palakkad district to delineate the sulphide-bearing zones in the ultramafic and mafic rocks and to evaluate their PGE potential. Detailed mapping on 1:1,000 scales was carried out for about 1.00 sq. km area in Elaichivazhi block. Sulphide mineralisation in the form of pyrite, chalcopyrite and pyrrhotite has been noticed mainly in metapyroxenite and at contact of metapyroxenite with metagabbro. A significant PGE mineralised zone was encountered in the northern part of Elaichivazhi block by surface exploration during field season 2018-19, for a strike length of 450 m and width varying from 2 to 5 m. Samples collected from three trenches yielded anomalous PGE values. Trench-2 analytical results yielded PGE value of 770 ppb Pt+Pd. In Trench-05, the total PGE values ranges from 05 ppb to 591 ppb in the samples collected from metapyroxenite and at the contact of metapyroxenite and metagabbro. Trench-04 showed that the total PGE values ranges from 19 ppb to 809 ppb. In Trench-6, the total PGE values ranges from 39 ppb to 538 ppb. A total of 500 m drilling were achieved. Five boreholes namely, KPE-01 (100 m) below Trench-2, KPE-02 (80 m) below Trench-3, KPE-03 (100 m) below Trench-1, KPE-04 (100 m) below Trench-04 and KPE-06 (100 m) below Ch-10/ near Trench-06 were drilled to intersect the mineraliszed zone at 50 m vertical depth from surface. The important rock types intersected in boreholes are metagabbro, anorthositic gabbro, and metapyroxenite with sulphide mineralisation.

In Uttar Pradesh, during reconnaissance survey (G4) for PGE mineralisation in Madaura area, Lalitpur district, an area of 100 sq. km was mapped on 1:12,500 scale. In the mapped area, lateralisation of the ultramafics has been observed in ultramafic bands exposed from Madaura to Markhera. Magnetite, haematite and quartz grains were found to be dispersed on the surface of the outcrops. The analytical results of 18 samples showed Cr values ranging from 2,000 to 2,868 ppm. The maximum values of Mn and Ni were 1,426 ppm and 1,229 ppm, respectively. Pd and Pt values of 20 samples have shown values ranging from less than 5 ppb to 18 ppb and less than 10 ppb to 52 ppb, respectively.

MECL

In Maharashtra, a G4 stage exploration was taken up in Pathri Saoli block in Saoli tehsil, Chandrapur district. Exploration comprised mapping of 160.00 sq.km area on 1:12,500 scale, sampling and analysis of 43 bedrock samples, 50 soil samples, 19 stream sediments samples and 5 whole rock study. Analysis of samples showed weak sporadic mineralisation in the block. The values of PGE and Cr in a few samples have been notable in isolated patches. No further study is proposed in this block. In Sindhudurg district, a G4 level exploration was taken up in Dhanoli bazar block with the objective to carry out mapping and demarcation of Au, Fe Ni, Cr and PGE-bearing formation including resource estimation. An area of 171.00 sq.km was mapped on 1:12,500 scale and 153 different types of samples were collected. Samples were analysed for Fe, Au, Ag, PGE (Pt, Pd, Ir, Ru, Rh & Os) and Cr & Ni. Higher values of Ni (>1,000 ppm), Cr (>1,000 ppm) and PGE (Pt>100

ppb) have been reported in areas of ultramafic bodies and in one laterite body. Four tentative potential zones for Ni, Cr and PGE were found near Gholawadi, Parpoli, Amboli and Fansawade areas. The values of Ni, Cr and PGE showed higher concentration in some ultramafic and latertite bodies (up to 2,297 ppm Ni in a lateritic body in eastern part of the block; 3,298 ppm Cr & 255.01 ppb Pt in Olive gabbro in the SE corner of the block). Resources of the block have not been estimated. The block is not promising for Fe, Au and Ag. The area falls in ecologically sensitive zone.

Directorate of Geology & Mining, Uttar Pradesh

Exploration work that started in 2000-01 to estimate resources of PGE in Ikauna area, Lalitpur district, was concluded in field session 2018-19. PGE mineralisation was found to be enriched in the area in altered periditite, talc-actonolite and chlorite schist over a strike length of 2.00 km with depth persistence of 60.00 m. Exploration comprises drilling of 20 boreholes to a cumulative depth of 3,497 m with average depth of 175 m, mapping of 1.12 sq.km area on 1:1,000 scale and excavation of 2,452 cubic meter material through 20 trenches. A total of 9,165 samples were collected and 2,377 samples were analysed. The PGE values were found to vary from 0.03 ppm to 4.85 ppm. Two samples were sent to IBM for beneficiation study. PGE resources of Indicated category has been estimated at about 8.37 million tonnes with an average grade of 0.40 ppm PGE.

Diamond

GSI

In Madhya Pradesh & Uttar Pradesh, a reconnaissance survey for kimberlite/lamproite was taken up in Ajaygarh block in parts of Panna and Chattarpur districts, Madhya Pradesh and Banda district of Uttar Pradesh. A pyroxenite body was identified in Bhawanipur of Ajaygarh block intruded in the medium-grained granite of Bundelkhand Granite Complex. A suspected diamond grain of 2 mm size was identified as KIM Kimberlite indicator mineral from the sample collected from Village Kauhari. SEM EDX study of the grain confirmed that it is a gem quality diamond without any inclusion. Further, SEM image of diamond showed that the edges of the diamond are sharp with solid angles with elongated and pyramidal hillocks, etc. indicating its proximal primary source.

Reconnaissance survey for kimberlite/ lamproite was taken up in Bariyarpur block in parts of Panna and Chattarpur districts, Madhya Pradesh and Banda district of Uttar Pradesh. In the Bariyarpur block, both ultramafic and mafic dykes were identified. Kimberlite indicator minerals (KIMs) like pyrope garnets, ilmenites, spinels, phlogopites and micro diamonds have been recovered during Heavy Mineral Studies (HMS) of stream sediment samples. Moissanite, a very rare naturally occurring silicon carbide mineral has also been found during HMS which indicates proximal source of diamondiferous kimberlite. This rare mineral has been reported for the first time in Panna Diamond Belt. Kimberlitic affinities of pyrope garnets, ilmenites, spinels, phlogopites later were confirmed by EPMA studies. Overall, the presence of positive KIMs indicates a proximal primary source rock. During field traverse, suspected altered lamproitic rock was observed in north-west of River Ken.

In Chhattisgarh, the reconnaissance survey was taken up with the objective to locate for kimberlite/lamproite clan rocks in Piparadhar and Maharajpur area in parts of Kabirdham district. The area that exposed rocks of Dongargarh Supergroup, Chilpi Group, Chhattisgarh Supergroup and Deccan Trap analysed 1,100 ppm of Cr and 205 ppm of Ni concentration indicating the nature of rocks to be ultramafic in nature. In Maharajpur area, a total of 17 circular to semi-circular intrusive bodies were observed. Carbonate veinlets of width about 35-45 cm and length up to 10 m cross-cutting Nandgaon andesite/andesitic-basalt were found to be sulphide-bearing. Pyroclastic breccia with angular and fragmented ilmenite crystals were observed at river section. At Piparadhar area, ultrabasic rock with conspicuous heavies were spotted at river sections.

In Karnataka, a reconnaissance survey to locate kimberlites in Bagalkot block, Bagalkot district was commenced in field session 2017-18. During the current field session 2018-19, 750 sq. km of aerial reconnaissance studies and 720 sq.km of reconnaissance survey were carried out on 1:50,000 scale in the area. Stream sediment sampling was carried out for recovery of heavy minerals and analysis of the same for search of any KIMS was

also conducted. The grains studied include garnets, ilmenites, spinels and diopsides. Most of the suspected ilmenites yielded very high amounts of manganese, iron enrichment, and resemble the character of ferricrete. However, none of the grains exhibited their kimberlitic source.

A two-year programme of reconnaissance survey has been taken up with an objective to search for Kimberlite clan of rocks in Kotturu block, Bellary and Davanagere districts. An area of about 750 sq. km was covered by aerial reconnaissance PGRS study with the help of ASTER data whereas 720 sq.km was covered by reconnaissance mapping on 1:50,000 scale. A total of 160 stream sediment samples that were collected thoroughly processed and 369 heavy mineral grains were sent for EPMA study to ascertain their kimberlitic origin. The heavy minerals collected during the FS: 2017-18 did not show their kimberlitic affinity. Two old workings, one probably for manganese or gold, were observed 4 km SE of Village Kanivehalli. The petrochemical analysis of the sample collected from Kurudi ultramafic body showed high values of MgO- 23.60%, Cu- 120 ppm, Zn -100 ppm, Ni- 850 ppm and Cr- 2,500 ppm.

In Meghalaya, a reconnaissance survey for Kimberlite Clan of Rocks (KCR) was carried out in and around Wageasi and Nongpoh Lailad area, East Garo Hills and Ri-Bhoi district. Area was mapped on 1:50,000 scale. From the petrological and mineral compositions, the lamprophyres have been categorised as monchiquites (alkaline lamprophyre). These lamprophyres are being reported for the first time from the Wageasi-Chibak area. Sporadic dissemination of sulphides, such as, pyrite, chalcopyrite and malachite were observed along Lailad-Umling road within the quartzo-feldspathic veins intruded within gneiss. Bedrock and petrochemical samples were collected along with stream sediment samples and petrological samples. The analytical results for base-metals were not encouraging. The KCR has not been reported during the present investigation.

In Telangana, a reconnaissance survey for primary source rocks of diamond was carried out in Kodangal-Parigi blocks, Mahabubnagar and Vikarabad districts. Aerial Reconnaissance and Satellite imagery study of 1,500 sq.km and field reconnaissance survey of 750 sq.km was carried out on 1:50,000 scale with collection of 206 stream sediment samples, 206 heavy mineral samples, 25 petrological samples and 5 petrochemical samples. Systematic orientation stream sediment sampling was carried out in Parigi block to narrow down the target area. Heavy mineral concentrates were prepared and picked for Kimberlite Indicator Minerals. The garnets recovered from the Parigi block were found to be non-kimberlitic in nature. The study of clasts >1.25 mm size and heavy mineral studies of stream sediment samples could not yield any diamond. The primary source rocks of diamond or kimberlite clan rocks could not be located.

Precious Minerals

Gold

The GSI, MECL and DGM, UP were engaged in the exploration for gold during 2018-19. An account of exploration work done by GSI is detailed in Table-7.

MECL

In Karnataka, G2 level exploration in BGML leasehold area for McTaggart's west lode Kolar Gold Field (KGF) was carried out with the objectives, to (i) know the continuity of lode/mineralised zones encountered during mine development as indicated in logitudinal-vertical section of Nandydoorg mine for McTaggart's west and east lodes, (ii) estimate gold resources in gap areas of earlier mines for McTaggart's west and east lodes, etc. Exploration work comprised mapping of 1.33 sq.km area on 1:2,000 scale, drilling of 8,395 meterage in 21 boreholes and collection of 2,931 samples. The total resources estimated was at 1.296 million tonnes with an average grade of 2.64 g/t Au at 0.50 g/t Au cut-off. Of which, Measured, Indicated and Inferred categories resources were 0.185, 0.387 and 0.724 million tonnes with average grade of 2.52 g/t Au, 2.75 g/t Au and 2.61 g/t Au, respectively. At 1.00 g/t Au cut-off. The total resources estimated was placed at about 1.044 million tonnes with an average of 2.97 g/t Au. Out of these, Measured, Indicated and Inferred categories resources were 0.180, 0.305 and 0.559 million tonnes with average grade of 2.52 g/t Au, 3.18 g/t Au and 3.18 g/t Au, respectively. The McTaggart's west lode holds 0.809 million tonnes

resources with an average grade of 2.18 g/t Au at 0.50 g/t Au cut-off. Parallel lode holds 0.487 million tonnes resources with an average grade of 3.4 g/t Au at 0.50 g/t Au cut-off. At 1.00 g/t Au cut-off, McTaggart's west lode holds 0.743 million tonnes resources with an average grade of 2.22 g/t Au at 1.00 g/t Au cut-off. Parallel lode holds 0.301 million tonnes resources with an average grade of 4.73 g/t Au at 0.50 g/t Au cut-off. The total metal content in the block is 3.417 tonnes at cut-off of 0.50 g/t Au. Out of these, 1,763 tonnes of metal is estimated in McTaggart's west lode and 1.654 tonnes of metal in Parallel lode. Similarly, at cut-off 1.00 g/t Au. The total gold metal estimated was 3.105 tonnes in this area. Out of which, 1.682 tonnes of metal have been estimated in McTaggart's west lode and 1.423 tonnes of metal in Parallel lode. A G3 level exploration was also carried out in BGML leasehold area for Oriental & McTaggart's west block. The total resources estimated in this area has been placed at about 1.008 million tonnes with an average grade of 1.14 g/t Au at 0.50 g/t Au cut-off. The Oriental lode (ORL) holds highest resources of 0.47 million tonnes with an average grade of 0.92 g/t Au at 0.5 g/t Au cut-off and rest of the quantity , i.e.,0.141 million tonnes is in McTaggart's west lode. The Uncorrelatable Lode (UC) holds highest grade of 1.49 g/t Au and the total resources of the lode has been estimated at 0.393 million tonnes with an average grade of 1.49 g/t Au at 0.50 g/t Au cut-off. The gold content in the block is estimated at 1,148.888 kg . The resources estimated for ORL are the highest among all three lodes however gold content of UC is highest, i.e., 583.713 kg. The McTaggart's west lode holds least gold content of 128.996 kg.

In Jharkhand, exploration for gold and base metal mineralisation was taken up in Bachkakhocha and Tankocha area of Saraikela-Kharsawan district. An area of 100.00 sq.km was mapped on 1:12,500 scale and 445 samples were collected for analysis which include 100 samples for REE analysis.

In Kerala, a G4 level exploration was taken up in Vettukathi Kotta block, Malappuram district. An area of 155.00 sq.km was mapped on 1:12,500 scale and 286 samples for different types of study were collected. The exploration activities was abandoned due to local problems.

In Rajasthan, a G4 level exploration for copper, gold and molybdenum was taken up in Karoli-Nathdwara block, Udaipur & Rajsamand districts. Exploration comprised mapping of 147.00 sq.km area on 1:12,500 scale and collection of 271 samples for different types of analysis/study.

Directorate of Geology & Mining, Uttar Pradesh

In Uttar Pradesh, DGM has continued exploration work in Hardi area (western block), Sonbhadra district with an objective to search for gold deposit in Hardi area. Detailed investigation of eastern block showed a gold deposit extending over a strike length of 1.2 km with average width and depth of 15.5 m and 18 m, respectively. The average grade of the ore is 0.30 ppm. The exploration in Hardi area (western block) comprised geological mapping of 0.5 sq.km area on 1:2,000 scale, excavation of 120 cu. m through 6 trenches of dimension 120 m x 1 m x 1m, and collection of 83 geochemical samples for chemical analysis. In Berwar area, Lalitpur district, search for placer gold was continued by geological mapping of 1.5 km^2 on 1:2,000 scale. About 91 m^3 material has been excavated in three trenches. One borehole was drilled for a depth of 63.43 m and 274 samples were collected for analysis. An average grade of 0.16 g/t Au was recorded based on chemical analysis received so far.

Hutti Gold Mines Company Limited (HGML)

In Karnataka, HGML has taken up exploration work in Hutti Gold Mine, Village Hutti, Lingasugur taluka, Raichur district, with an objective to undertake explotation of gold and other associated minerals. An area of 2,772 sq.m underground mapping was carried out on 1:400 scale and 15 boreholes were drilled to a cumulative depth of 521.00 m which included 2 surface and 13 underground boreholes. A total of about 16.88 million tonnes reserves were estimated including 16.30 million tonnes at 4.41 g/t Au content under Proved and 0.58 million tonnes at 4.58 g/t Au content under Probable categories.

Industrial Minerals

The details of exploration carried out for industrial minerals by GSI, State governments and Central/State Undertakings during 2018-19 are furnished in Table - 8.

Table - 7: Exploration for Gold by GSI, 2018-19

State/District	Location	Details of work done	Results obtained/Remarks
Arunachal Pradesh			
Papum Pare	Ampuli area	Mapping, Drilling & Sampling	Preliminary exploration for gold and associated base metal mineralisation involved detailed mapping over an area of 1 sq.km and systematic drilling in the northern part of the block. A limonitised zone in schistose quartzite intruded by granitic and quartz veins showed Au concentration up to 1,158 ppb and was traced up to 210 m in strike extension.
Chhattisgarh			
Jashpur	Barjor area	Mapping & Sampling	During reconnaissance survey for gold and associated sulphide mineralisation, an area of 100 sq. km was covered by on 1:12,500 scale in Barjor block. The area exposed granite with enclaves of meta-gabbro with numerous networks of sheared ferruginised tourmaline-bearing quartz veins and milky white quartz veins. The mineral assemblage indicates that the rocks have undergone regional metamorphism in greenschist to lower amphibolite facies. Quartz veins exposed near Barjor, Sabadmunda and Tilanga area contain disseminated pyrite, chalcopyrite, covellite, malachite and arsenopyrite. The metagabbro and granite also contain disseminated pyrite and chalcopyrite. Strike length of the mineralised quartz vein varies from 1 km to 2 km with width varying from 3 m to 50 m. Analysis of bedrock samples indicated Au value up to 11 ppm with average 1,634 ppb in quartz vein and metagabbro. Also 0.28% Cu, 0.27% Pb and 8 ppm Ag values were detected from the quartz veins of the study area.
Jharkhand,			
Saraikela-Kharsawan	Jilingda-Kharsawan-Dugni areas	Mapping & Sampling	Reconnaissance survey for gold and associated minerals involving Large-Scale Mapping of 100 sq. km on 1:12,500 scale was taken up along with collection of 100 bed rock samples (BRS) and 100 pitting and trenching samples (PTS). Mineralisation in the form of pyrite, chalcopyrite, pyrrhotite and malachite stains observed in sheared quartzite, hornblende schist and chlorite phyllite was dissemination and stringers. Visible specks of gold were observed in stream sediment samples from south of Patahatu and north of Jilingda. The results show gold value of 60 ppb to 80 ppb in eight samples in quartzite of Sanjay hill and hornblende schist in the east of Rampur and brecciated quartzite near Sokandih. Four samples of quartzite showed Cu value ranging from 1,228 ppm to 2,521 ppm.
Jharkhand			
Ranchi	In and around Kubasal, Jargo, Serengdih areas	Mapping & Sampling	During reconnaissance survey for gold and associated minerals, an area of 110 sq. km was covered by Large- Scale Mapping on 1:12,500 scale. Four distinct shear zones identified in the area have been found to be represented by several hydrothermally altered brecciated quartz reefs of dimension 5-20 m wide and 20-40 m long. Specks of sulphides mainly

Table - 7 (Contd)

State/District	Location	Details of work done	Results obtained/Remarks
			pyrite and chalcopyrite are seen in brecciated quartz reefs. Suspected arsenopyrite and bornite have also been noticed. Pockets of manganese mineralisation in the form of psilomelane and pyrolusite are also present. Analytical results of two bedrock sample showed anomalous concentration of gold values of 85 ppb and 115 ppb. Visible specks of gold flakes are noticed in panned stream sediments collected from different orders of stream.
Jammu and Kashmir			
Leh	Nornis, Kesar and Kidmong areas	Mapping & Sampling	Reconnaissance survey in the area was carried out with primary objective to assess the potentiality of gold and PGE elements within the Kyun Tso mafic-ultramafic body and its surrounding rocks. An area of 50 sq.km was mapped on 1:12,500 scale. Sampling for PGE was done in dunite, peridotite, pyroxinite, gabbro and basalt. Seventy-eight samples were sent for chemical analysis of Ni-Cr-Cu and SiO_2, LOI and Cr_2O_3.
Karnataka			
Haveri	Belgalpet-Balambid block, Hangal taluk	Mapping & Sampling	Reconnaissance survey in part of T.S. No. 48N/1 was taken up under G-4 stage with an objective to assess the potentiality of gold in the area. The exploration work included ASTER image processing of 720 sq. km, Large-Scale Mapping of 100 sq. km on 1:12,500 scale, etc. A total of 103 bedrock samples and 50 trench samples were collected and analysed for Au and other associated elements. At Adur, the Banded Magnetite Quartzite (BMQ) has a strike length of approx. 500 m long. The width of iron and siliceous layering showed variations from 0.2 cm to 1 cm. Both bluish quartz and milky quartz veins were found along the band. The disseminated sulphides of pyrite and aresenopyrite have been observed at places. The bluish smoky quartz veins have been observed in the strike direction of the BIF. Gold value in six bedrock samples was found to vary from 25 ppb to 196 ppb. The study will continue in field session 2019-20.
Karnataka			
Haveri	Hotanhalli block, Hangal Taluk	Mapping, Pitting and trenching & Sampling	Reconnaissance survey for gold was carried out to assess the gold potential in the area. An area of 100 sq. km was covered by Large-Scale Mapping on 1:12,500 scale with pitting and trenching of 65 cu.m and geophysical survey of 42.85 l km. Five sulphide-bearing BIF zones were identified with variable dimensions in east of Yelvatti (750 m length x 5 to 50 m width), Gundur (750 m x 3 – 50 m and 300 m x 2.25 m), Belvatti (2.3 km x 5 to 70 m and 1.7 km x 0.5 m to 50 m), Bhingapur to Sidlapur sector (8.75 km x 0.5 m to 80 m) and two isolated BMQ/BFC bodies were also identified in Valgeri area. Among these zones, Gundur block is a potential zone for gold based on the analytical results which indicated Au value ranging between 1.009 ppm and 51.733 ppm in 9 samples, 37 ppb and 404 ppb in 17 samples and < 25 ppb in 8 samples consistent with high chargeability.

Table - 7 (Contd)

State/District	Location	Details of work done	Results obtained/Remarks
			The potentiality of the area for gold mineralisation will be assessed after complete receipt of chemical results.
Tumakuru	Ajjanahalli Block-I	Mapping, Trenching,Drilling & Sampling	Preliminary exploration for gold was carried out in Ajjanahalli Block-I with detailed mapping of 2.0 sq. km on 1:1,000 scale, trenching, drilling, sampling and ground geophysical survey. Alteration zones (carbonates, chlorite and silica), shearing features that form important evidences of mineralisation, were delineated during the study. A total of 117 trench samples and 127 bedrock samples were collected for gold analysis. Encouraging results were observed in trench samples. Ground geophysical survey of 20 Line km was carried out in the eastern part of the study area. Integration of geological and geophysical maps helped in identification of two discrete N-S trending IP anomaly zones. Five boreholes were drilled to a cumulative depth of 653.25 m. All the boreholes have intersected the targeted mineralised zones in BIF and quartz veins. Mineralisation in the area is confined to sheared and brecciated BIF with quartz-carbonate, chlorite veins with sulphides minerals i.e. pyrrhotite, pyrite, arsenopyrite and chalcopyrite. The study will continue in field session 2019-20.
Davanagere and Bellary	Kanivehalli	Mapping & Sampling	Reconnaissance survey was taken up in Kanivehalli and adjoining area to evaluate the potentiality of gold and associated minerals with special emphasis to understand nature and control of mineralisation. An area of 100 sq.km was mapped on 1:12,500 scale. The Cu values varying from 200 ppm to 2,700 ppm were reported from the PGC hosted giant quartz veins. The mineralisation is characterised by the presence of malachite, chalcopyrite, pyrite, arsenopyrite with ferruginous, K-feldspar and epidote alterations. The Au values reported from the BIFs intruded by fine quartz veins vary between 25 ppb and 216 ppb.
Karnataka			
Koppal & Bagalkot	Ilhal area	Mapping, Trenching, Drilling & Sampling	A two year programme on reconnaissance survey for gold mineralisation was taken up during 2018-19. During the field season, 35 sq.km Large-Scale Mapping on 1:12,500 scale, 0.30 sq.km detailed mapping on 1:2,000 scale and 36 cu.m of trenching were carried out. The major rock types exposed in the area are massive metabasalt, pillowed hornblende gabbro, metagabbro, metapyroxenite, dolerite, pegmatite, quartz vein, etc. A few thin silicified zones observed at SW of Tallikeri, SE of Kellur and NW of Ilhal villages, contain pyrite. Surface mineralisation in the form of dissemination of pyrites was noticed in thin quartz vein, massive metabasalt and schistose metabasalt at several places. Four old workings (20 m x10 m, 3 m x 2 m, 6 m x 4 m, 5 m

Table - 7 (Contd)

State/District	Location	Details of work done	Results obtained/Remarks
			x 2 m) were observed. During survey, bedrock samples, trench samples and stream sediment samples were collected to find out the gold concentration. The exploration will continue in 2019-20.
Haveri	Hosa Hulihalli, Halageri	Mapping, Trenching, Drilling & Sampling	During reconnaissance survey for gold, an area of 100 sq.km was mapped on 1:12,500 scale. Sulphide mineralisation was found manifested in the form of pyrite, chalcopyrite, pyrrhotite and arsenopyrite in the BIF and quartz vein. Surface alterations like oxidisation, limonitisation, silicification and carbonate vein intrusion were noticed in the BIF, metabasic rock and quartz vein. Three possible blocks were identified based on the surface manifestation of sulphide mineralisation and surface alteration i.e, Kakol south-west block hosted in BIF, Yerekoppi block hosted in quartz vein and Salagudda block hosted in BIF. The chemical analysis of stream sediment samples, soil samples and bedrock samples showed Au values ranging up to 31 ppb, 85 ppb and 592 ppb in Kakol south-west block, respectively. BRS of Salagudda block showed Au value up to 1,230 ppb. Trench samples reported gold values from 32 ppb to 114 ppb.
Madhya Pradesh			
Singrauli	Budhadol-Sulkhan area	Mapping, Pitting/ Trenching & Sampling	During G4 stage survey for gold and associated sulphide mineralisation, an area of 100 sq. km area was mapped on 1:12,500 scale. Mineralisation was mostly noticed in smoky and mixed quartz veins and at some places white quartz veins have also shown good evidences of mineralisation. Mineralisation in quartz veins was found to occur in the form of pyrite, chalcopyrite, galena, arsenopyrite, malachite and pyrrhotite as vug or fracture filling within the quartz veins. Besides Large-Scale Mapping, bedrock samples, petrochemical samples, petrological samples, EPMA and pitting/trenching samples were also collected for chemical analysis. Pitting/trenching was carried out in ferruginous phyllite, quartzite and quartz vein to find subsurface indications of mineralisation. An aerial reconnaissance and PGRS study of 700 sq. km. area was carried out to reveal presence of altered clay minerals.
Sidhi	Dudhmania block		During reconnaissance survey for gold, REE and associated mineralisation, various lithounits observed and demarcated in the area were sulphidic chert bands, BIF bands inter-banded with phyllite, green colour khaki phyllites, tuffaceous phyllites, ferrugenous phyllite, greywacke/ quartzwacke interbanded with phyllite, biotite schist, metabasalt and intrusives in the form of dykes

Table - 7 (Contd)

State/District	Location	Details of work done	Results obtained/Remarks
			(Meta dolerites/ Metagabbro) and quartz veins. Pyrite, chalcopyrite and arsenopyrite were noticed as fracture fillings within sulphidic chert and BHC near Village Jardha . Disseminated grains of pyrite, chalcopyrite, galena and arsenopyrite were observed within BHC and small quartz veins near Bagdari, Siyari, Chelwa, Gidher village. Quartz vein containing stains of malachite, grains of galena and arsenopyrite were observed near Village Parihasi. Sulphide mineralisation was found mainly in the form of disseminated grains and specks in quartz veins and at few places in smoky quartz veins near to Village Majhigawan . Chalcopyrite and pyrite are also seen in Bandar Ghori, east of Village Pokhra, SW of Village Jurnie and near Village Majhigawan. Mafic bodies were seen mainly of two types, i.e., one is parallel to bedding and other showing cross cutting with host rock and are mineralised.
Madhya Pradesh			
Singrauli	Around Birkuniya – Barawani – Chatri area	Mapping	Large-Scale Mapping of 100 sq. km was carried out to delineate mineralised zones for gold and iron bands. Demarcation of sulphide minerals bearing smoky quartz veins was done along with iron bands within the banded ferruginous chert/ quartzite and magnetite bands in BMQ. The sulphide mineralisation was observed mainly in smoky quartz veins as well as in chert band and other intrusives. The occurrence of sulphides was seen to be sporadic and scattered within the rock. They are mainly arsenopyrite, chalcopyrite and pyrite. The mineralised quartz veins are primary and smoky in nature whereas the milky ones are secondary and non-mineralised.
Tamil Nadu			
Tiruvannamalai	Edathanur and Pudurnattam	Mapping	Reconnaissance survey for gold and associated mineralisation was taken up in and around Edathanur and Pudurnattam area. Large-Scale Geological Mapping (LSM) on 1:12,500 scale was carried out covering an area of 100 sq. km. The objective of the study is to identify and delineate the potential zones for gold mineralisation. The area comprises of charnockite, pyroxene granulite and BIF (banded magnetite quartzite) of Charnockite Group, migmatite and pink granite gneiss of PGC-II, basic intrusive and younger granite. Basic dyke traverses the country rocks along NW-SE to E-W direction.
Uttar Pradesh			
Sonbhadra	Gulaldih area	Drilling	Preliminary exploration for gold was carried out to assess the potentiality of gold mineralisation in the central block of Gulaldih area. A total of 2,402.60 m of drilling was completed. Sulphide mineralisation in the form of pyrite, arsenopyrite and pyrrhotites with minor presence of chalcopyrite was confirmed in different boreholes at varying depths.

Table - 8: Exploration for Industrial Minerals by GSI, DMG/DGM, MECL, KSMCL, RINL & GMDC, 2018-19

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
GSI							
Apatite							
Jharkhand							
East Singhbhum	Around Gopalpur-Katin-Bankuchia areas	1:12,500	100.0	-	-	310	G4 stage reconnaissance survey for apatite magnetite rocks and associated mineralisation was taken up with an objective to assess the potentiality of apatite, titanium and REE mineralisation in the area. During the course of field study, different lithologies viz. apatite-magnetite bearing metabasic, amphibolite, calc-silicate acid volcanic, tuffaceous quartzite and banded magnetite quartzite, etc. were recorded. Further, the apatite veins within the metabasic rocks have not been observed. Part analytical results showed that the area is devoid of any REE potentiality. However, the P_2O_5 content was seen varying from 0.14% to 3.60%, TiO_2 content varying from 0.21% to 5.02%, and Ba content from 64 to 1,449 ppm. Analytical results and other lab studies are awaited.
West Bengal							
Purulia	Sankari-Gurda-Hijla sector	1:12,500	100.0	-	-	200	G4 satge reconnaissances survey was taken up to assess the potentiality of apatite and rare earths mineralisation along the shear zone in the gap area between Medinitanr and Dandudih-Gamardih. Large-Scale Mapping along with systematic collection of bedrock samples and petrochemical samples (150 BRS + 20 PCS) from the major lithounits recorded in the area was carried out. Pitting /trenching of 126 cu.m was carried out to delineate extension of the already identified apatite body at Dandudih/Kutni area. No new discovery of apatite body was established in the field. The extension of the apatite body at Kutni has been demarcated to be approximately 300 m west of the existing outcrop. Petrographical studies (30) have been carried out. Numerous sulphide veins have been noticed in tuffaceous rocks present in the southern part of the study area.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Glauconite Chhattisgarh							
Baloda Bazar	Girodh area	1:12500	100.0	-	-	-	G4 stage reconnaissance survey for glauconitic sandstone for its potash content was taken up in and around Girodh area within Kansapathar formation. About 18 km long and ~0.35 to 4.5 km wide glauconitic horizon was seen represented by reddish brown and purple glauconitic quartz arenite. The glauconitic band showed glauconite of various sizes (0.5 mm to 2 mm) and shapes. Overall, the volume percentage of glauconite in the sandstone varies was seen to vary from 0.5 to >15%, the average value being 4-6%. Analytical data of some samples showed K_2O value up to 5.84% in BRS samples. Enriched mineralised zones of glauconite was identified around west of Uprani, Girodh, south of Girodh, north of Manakoni, NNW of Daldali, North of Gindola in Kansapathar Formation. Sulphide mineralisation like pyrite, chalcopyrite and arsenopyrite was identified in meta-basalt and gabbro in the north of Village Kunkuri and in amphibolite near Village Maharaji . Gold grain was observed in sandstone near Village Bhadora. BIF band was noticed near Village Kukrikona at the southern boundary of the block. Sulphide mineralisation was noticed in black limestone near Motipur and Bareli villages.
Glauconite Chhattisgarh							
Raipur	Around Kareli - Khurd, Shuklabhata & Panduka area Raipur, Gariaband & Dhamtari	1:12500	100.0	-	-	50	The LSM of 100 sq. km area on 1:12,500 scale revealed granitic basement, basal arkoses of Lohardih Formation and glauconitic sandstones of Kansapathar Formation. The continuous belt of glauconitic sandstone is observed in the south central and central part of study area that passes through

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							Bondrabandha, Atarmara, Kumharmarra, Sankra and Phuljhar. East of Kutena and in south of Phuljhar, glauconite is observed to form distinct beds of green colour parallel to the bedding of the host rock. Partly altered glauconitic pellets are also observed. The maturity of glauconite is mostly nascent, i.e., 2-4% K_2O throughout the study area. At Kumharmarra and Sankra, the glauconite variety is intermediate, i.e., 4-6% K_2O while at Kutena and Phuljhar, the variety is mature i.e., (>6% K_2O). Petrographic studies showed feldspar replaced by glauconite. Analytical results of 50 bedrock samples showed K_2O values mostly in the range of 0.19-1.86 wt. % except 3 samples which vary between 2.12 and 3.32 wt%. Petrochemical study of 8 samples shows K_2O values ranging from 0.1-3.41 wt% Analytical results of 8 pit and trench samples showed K_2O values in the range from 0.1-3.41 wt% in these samples which does not corroborate with the observed modal proportion of glauconite in the field study. Relatively better values reported from XRD samples, which showed glauconite varying between 7 and 9%. The origin of glauconite could be attributed to replacement of feldspar in a stable shelf environment.
Madhya Pradesh							
Singrauli	Bardi block Chitrangi Tehsil	1:12500	2.0	-	602.45	52	G3 stage preliminary investigation for glauconitic shale/sandstone was taken up. Thin bands of glauconitic shale/ limestone have been noticed within the green/grey shale and fawn limestone. The glauconitic shale/limestone is bluish-green in colour. In Bardi block, dark bluish-green colour,

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							sub-rounded to rounded pellets of glauconite is clearly visible in coarse-grained glauconitic sandstone. These pellets also form thin laminations in fine to medium- grained sandstone. Glauconite grains/ pellets of bluish-green colour were noticed in fawn limestone. Thin bands of glauconitic shale were noticed within the green/ grey shale and whitish grey clayey shale. Three modes of occurrence of glauconite were reported in the mapped area. (i) Thin lamination: Bluish-green coloured glauconitic laminations are noted in glauconitic shale, fine to medium-grained sandstone and intercalated whitish grey clayey shale-pale green shale. (ii) Inter-granular space filling: in coarse-grained glauconitic sandstone, glauconitic grains occur as inter-granular grains between quartz grains. In limestone, bluish-green colour glauconite grains are associated with allochem. (iii) Fracture filling: Fracture filled bluish-green colour glauconite is noticed in limestone. The analytical results of 34 core samples collected from two boreholes showed encouraging values for K_2O concentration which ranged from 5.04 to 9.57%, while 18 BRS samples showed K_2O value varying from 6.04 to 11.27.
Glauconite							
Rajasthan							
Karauli	Vindhyan Super group	1:12500	50.0	-	-	120	G4 stage reconnaissance survey for glauconite sandstone/shale of the Vindhyan Supergroup exposed in parts of Karauli district was taken up. During the Large-Scale Mapping, glauconitic sandstone/shale was delineated in the rocks of Jhiri Formation within Rewa group of lower Vindhyan. The glauconitic

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							sandstone from Asthal showed a visual estimate of 60-80% glauconite mineral. Chemical analysis of bedrock samples indicated that olive green to Khaki shale from Jhiri Formation contain maximum K_2O of up to 6.23% with an average value of 4.74%.
Potash/Gypsum							
Punjab							
Fazilka & Muktsar	Qabrwala block	1:4000	5.25	01	2600	-	G4 stage reconnaissance survey for potash, gypsum and associated sulphates was taken up in Qabrwala block in parts of Fazilka and Muktsar districts. The area forms northern extension of Nagaur-Ganganagar evaporate basin extending in south-western part of Punjab. A borehole had intersected the evaporite zone, i.e.,target zone of mineralisation at a vertical depth of 516.20 m. Gypsum and anhydrite/sulphates occur as intermittent bands, lamellae ranging in size from 1 mm to 1.99 m from the depths of 516.20 m to 597 m. The study will continue.
Phosphorite							
Himachal Pradesh							
Sirmur	Lower Tal	1:12500	50.0	-	-	-	G4 stage reconnaissance survey for phosphorite was carried out in northern, southern and hinge zone of the Nigalidhar syncline in Lower Tal (Shaliyan formation). On the basis of analytical data, four potential phosphorite mineralisation sections were identified: (i) Khill-Kanti-Mishwa section — Phosphatic chert band of strike length of approximately 2.9 km with average thickness of around 15 to 18 m. Partial analytical analysis data showed value of P_2O_5 ranging from 2% to 5% while in one samples it was 10.62%; (ii) Kathwar-Tipri section — the strike extension of this section showed 225 m to 250 m with average thickness of about 18-20 m. In

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							phosphatic chert, value of P_2O_5 ranged from 2% to 5% and in two samples it recorded 15.32 and 9.19%; (iii) Kandi-Kiyana section — the strike extension of this section was 225 to 250 m with a maximum thickness of about 10-12 m; (iv) Pherog-Bakras section—the strike extension of this section was 180 to 200 m with a maximum thickness of about 15-20 m.
Jammu & Kashmir							
Doda & Kathua	South of Benhencha	-	-	-	-	88	G4 stage reconnaissance survey for phosphorite was taken up with the main objective to evaluate the potentiality of phosphorite in the rocks of Gamgul Formation (Salooni Formation). The Gamgul Formation comprised of carbonaceous shales, silty shale and calcareous sandstone. The phosphorite nodules have been observed in carbonaceous shale/shaly slate of the Gamgul Formation. The nodules ranged in size from 4 cm x 4 cm to 21 cm x 12 cm. On an average 5 to 10 nodules in 2 m x 2 m have been observed at Biddi, BhalPadri areas and 2 to 3 in Chimlo Di Gali and Gamgul area. the other prominent locations where phosphatic nodules have been noticed & sampled are Biddi, Chimlo Di Gali, Golu Di Mandi, Thoran, Gamgul and BhalPadri. Out of the 88 samples, chemical results of 8 samples yielded P_2O_5 values from 1.34% to 6.56 %. These samples also contained substantial amount of barium and vanadium. The project will continue in field season 2019-20.
Jharkhand							
Garhwa	Muskaniya-Sinduria area	1:12500	200.0	-	-	-	G4 stage reconnaissance survey for phosphate & potash fertilizer mineral in and around Muskaniya-Sinduria areas involved large-scale mapping of 200 sq. km area during field season 2017-18 & 2018-19. Positive spot values of P_2O_5 have been recorded in brecciated quartzite (4.3 and 4.9 % P_2O_5)

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							and ferruginised quartzite (3.3 to 3.5 %P_2O_5) near Ghagra to Phulwar and Chatanian area. Based on this result, mineralised zone for phosphate was delineated from Ghagra to Phulwar and near Chatanian area in brecciated and ferruginised quartzite. Encouraging values of potash have been noticed in green/ khaki green shale (5.3–8.7 % K_2O), green sandstone (6.2–7.7 % K_2O), chert interlayered with shale (5.2–9.10 % K_2O) and green cherty quartzite (5.2–8.1 % K_2O) during field season 2018-19. Based on these significant potash values, mineralised zones for potash were demarcated near Chaura, south of Parsodih, near Kewaltola and near Gurur area.
Meghalaya							
East Jaintia Hills	Pala–Larket Village, Litang Valley	1:12500	50.0	6	293.2	164	G4 stage reconnaissance survey for phosphate in shales of Kopili Formation in and around village Pala-Larket included large-scale mapping, pitting and trenching, drilling, collection of 154 core samples and 10 samples for XRD studies.Three alternative marl and shale horizons were studied in various sections. Phosphate nodules were found to be scattered in the lowermost shale horizon above the contact of Shella Formation. Phosphatic nodules of few centimeters to 10 cm in size were noted in the transition zone of Shella and Kopili Formations which was about 1.5 to 2 m thick zone. The average concentration of nodules per unit volume recorded was 0.002 cu.m. In nodules, P_2O_5 content varies from 5.23 to 16.70%. Shale and Marl showed an average concentration of below 1%. The study will be continued in field season 2019-20.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Graphite							
Arunachal Pradesh							
East Kameng & Papumpare	Pakro-Rilo-Pakke Kessang & Longchung-Sagali-Balapu	1:12500	120.0	-	-	70	G4 stage reconnaissance survey for graphite, associated base metal and REE mineralisation was taken up in Pakro-Rilo-Pakke Kessang and Longchung-Sagali-Balapu sections. The area covered by large- scale mapping followed by 44 cu. m trenching. The highest copper value 1,050 ppm was reported in spot sample and highest value of vanadium reported from 36 m long channel in meta-sedimenatries was 2,493 ppm. Seventy soil samples have been collected from the different soil horizons from a granitic terrain to identify the possibilities of REE mineralisation in the mapped area. Rilo granite was observed to be intruded by clay veins of thickness up to 30 cm which yielded TREE value of about 1,068 ppm near Village Rilo. The exploration will continue in field season 2019-20.
Dibang valley	Hunli area	1:12500	50.0	-	-	-	G4 stage reconnaissance survey for graphite was undertaken around Hunli area, Dibang Valley district with an objective to delineate and assess the economic potentiality of the area for graphite. Three major bands of carbonaceous phyllite were reported in the Hunli area with the prominent band having the true thickness varying in the range between 150 and 800 m with strike extension of around 2.5 km – 3.0 km. The other two bands have thickness varying between 150 and 200 m with the strike extension of 1.0 km – 1.5 km. The study will continue in field season 2019-20.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Graphite							
Chhattisgarh							
Balrampur	Baharchura, Tikidiri, Revatipura & Oranga area	1:12500	100.0	-	-	-	G4 stage reconnaissance survey for graphite in Baharchura, Tikidiri, Revatipur and Oranga area involved large-scale mapping followed by 75.65 cu. m trenching and 10 l km geophysical survey along with collection of other samples. Graphite mica schist was found to occur as a continuous band with minimum width of 3 m near Village Oranga to a maximum of 130 m near Village Revatipur. Graphite of flaky nature is present in the area. Graphite mica schist samples analysis showed fixed carbon content varying from 4.51 to 16.27%, volatile matter varies from 1.24 to 3.94%, ash content from 80.15 to 91.88% and moisture content from 0 to 0.94%.
Madhya Pradesh							
Alirajpur	Juwari Bari-Chhoti-Rampura-Jorbat area	1:12500	108.0	-	-	237	A G4 stage reconnaissance survey in the area included large-scale mapping, collection of 106 bed. rock/ channel samples and 105 PT samples for search of graphite mineralisation, 26 BRS for base metal analysis and geophysical survey (IP, SP, Magnetic and Resistivity) of about 14.19 l km area. During mapping, three separate discontinuous zones were demarcated: (i) The eastern zone, having a cumulative length of about 900 m with width varying from 13 m to 24 m was exposed discontinuously from Betwasa in the south up to Kosduna in the north. A trench showed 18 m thick mineralised zone having 2.90% average fixed carbon values at 2% cut off, (ii) The central zone was discontinuously exposed from Dehdala to west of Rampura over a cumulative strike length of about 2.7 km with thickness varying from 8 m to 22 m. The trench

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							and channel samples indicated 7 m to 16 m thick graphite-bearing zones with average fixed carbon value varying from 1.18% to 2.13% at 2% cut off and (iii) The western zone from Chamarbegra to Juwari Bari was discontinuously exposed over a cumulative length of 3.70 km with width varying from 5 m to 30 m. It showed 2.72% and 4.55% average fixed carbon values at 2% cut off in trench and channel samples with width varying from 5 m to 9 m. To the northeast of Juwari Bari, a separate thick carbon phyllite/graphite schist associated with grey carbonaceous marble was demarcated having a length of about 1.65 km and width of about 160 m. Five grab/ spot samples from this band indicated fixed carbon values ranging from 3.08% to 16.88%. Apart from graphite mineralisation, a sheared quartz vein with a length of about 1.25 km and width of 10-20 m showing evidences of copper mineralization in the form of malachite staining, small specks of chalcopyrite and chalcocite also was recorded in the east of Kosduna. Out of 03 samples, one sample indicated 1.45% copper.
	Netara-	1:12500 Khattali Bari-Phata Dam area	100.0	-	-	203	G4 stage reconnaissance survey was taken up in the area included collection of 77 bedrock/channel samples, 101 PTS and 25 BRS for base metal analysis. Geophysical survey (IP, SP, Magnetic and Resistivity) of about 11.2 l km area in prospective areas for graphite mineralisation was also taken up. During mapping, two main separate discontinuous graphite-bearing zones were recorded in carbon phyllite associated with grey phyllite. The eastern mineralised zone recorded near Village Netara

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							was about 8 m to 25 m in thickness and with cumulative strike length of about 1.5 km. The trenches in this area indicated two to four graphite mineralisation of width varying from 1 m to 12 m. The analytical results of BRS showed fixed carbon value varying from <1% to 15.8% and in trench samples from <1 % to 11%. In the western graphite-bearing area in south to SE of Village Jamani, two separate closely spaced linear zones of graphite schist/carbon phyllite were traced for a cumulative strike length of over one km with width varying from few meters to 10 m. The BRS in Jamani area showed the fixed carbon content ranging from <1% to 9.61%. The graphite schist /carbon phyllite in the east of Village Kherwa recorded a cumulative strike length of 700 m with thickness ranging from 4 m to 10 m.
Madhya Pradesh							
Graphite							
Betul	Golighat block	1:2000	1.25	21	1746.30	-	Under G-2 stage of investigation, an area of 1.25 sq. km, (1.15 sq. km in Golighat-Makra main block and 0.10 sq. km in Junawani block) was mapped on 1:2,000 scale. Geophysical survey in western part of the Golighat-Makra main block has also been carried out in continuation of geophysical survey in Golighat area (which was covered during FS 2017-18) to evaluate the extent and potential of graphite mineralisation. The IP/resistivity survey in Golighat-Makra main block helps in delineating host rock and extent of graphite mineralisation in soil cover areas. The graphite schist associated with quartz mica schist was found to occur as enclaves within the granite/ granite gneiss. A total of 1,746.30 m of drilling in 21 boreholes (comprising 09

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							first, 06 second and 01 third level borehole in Golighat area, 02 each of first and second level boreholes in Makra area and 01 first level borehole in Junawani area) have been carried out. The boreholes were drilled at 200 m interval targetting to intersect mineralisation at 30 m, 60 m and 90 m vertical depth in 1st, 2nd and 3rd level boreholes, respectively. All boreholes except one borehole intersected two to three zones of graphite mineralisation of various thicknesses. The width of mineralised zones showed variance from 0.50 m to 17.30 in along the borehole. The subsurface data indicated that the width of mineralised zone vary along the strike as well as depth showing pinching and swelling nature. The graphite mineralisation in Golighat area occur as two separate lenses of 800 m and 600 m strike length with cumulative strike length of 1,400 m. In Makra area, the strike length of graphite-bearing mineralised zone was about 300 m and may continue further east. The chemical analysis results received so far indicate that the average fixed carbon value in intersected mineralised zones varies from 1.21% to 12% in Golighat area and 1.71% to 11.90% in Makra area. In Junawani area, only one borehole was drilled and this intersected two very thin mineralised zones of 0.40 m and 1.10 m only. The strike length of graphite schist was observed to be only 90 to 100 m. Therefore, no further drilling was carried out in Junawani area. The subsurface drilling data indicates that the host rock for graphite in mineralisation is graphite-bearing quartz mica schist intruded by later granite along the foliation planes. Largely Contd

Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							the graphite-bearing bands are found in association with granite/granite gneiss and sometimes as interbands within the quartz mica schist. Shearing is dominant in the eastern part of Golighat-Makra main block where graphite mineralisation is associated with brecciated cherty granite and graphite is also remobilised along fracture planes. The graphite is grey to greyish black in colour, soft, greasy, schistose and flaky in nature. Small flakes of steel grey graphite are mixed intimately with muscovite flakes and ash grey powdery material in the graphite schist. Based on the work carried out under G3 stage of investigation, the item is seamlessly upgraded to the G2 stage of exploration in Golighat block. Study continued as spillover in FS 2019-20.
Odisha							
Graphite							
Angul	Adeswar-Ambasarmunda-Dhauragoth area	1:12500	100.0	5	419.45	-	During G4 stage reconnaissance survey, large- scale mapping, pitting-trenching (100 sq. km.) and drilling was carried out in this area. Geophysical anomalies observed in previous field studies have been demarcated during large-scale mapping and through trenching. Anomalies were demarcated near Village Bandagan (about 100 m strike length),Bandagan- Talamaliha road (50 m strike length), near south of Village Ambasarmunda (300 m strike length) and Village Akharkata (50 m strike length). Besides, 3 new graphite bands were identified in south of Village Talamaliha (50 m strike length), near Bandhagan school (50 m strike length) and near Village Mindol (200 m strike length). Five boreholes have been completed and one is in progress. All the boreholes intersected graphite of variable width at different depth. Part analytical results of pitting-trenching samples collected along the profile of borehole ODADW-01 showed a zone of 3.0 m x 6.93% F.C., ODADW-

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							02 (PTS 4) showed a zone of 4.0 m x 5.1025% F.C. and the analytical results of PTS-03 (along the profile of borehole ODADW-05) showed 2.0 m x 5.41% FC and 2.0 m x 4.84% F.C. The analytical results of 25 BRS showed <1% F.C to 27.53% F.C. About, 11 samples showed more than 5% F.C value. The exploration will continue in field season 2019-20.
Bihar							
Rohtas	Bhora-Kathra block	1:4000	5.6	13	999.5	-	G3 stage preliminary exploration for limestone in Bhora-Kathra block was carried out as requested by DGM. The exploration block was found mostly covered by alluvium where the target litho-unit, i.e., Rohtas limestone was exposed in the scarp faces of the abandoned mines/quarries. The limestone was seen intercalated with shale and a few thin cherty bands. Drilling of 11 boreholes has been completed and drilling of two boreholes is under progress. Drilling has been carried out in 800 m x 800 m grid spacing followed by infilling in 400 m x 400 m spacing. Limestone was intersected mostly at depths varying from 20 m to 30 m although a few boreholes intersected limestone at shallower depths. The general thickness of the mineralised zone in all the boreholes was found to be around 30 m–40 m. Analytical results of 199 core samples have been received. Exploration will continue in field season 2019-20.
Chhattisgarh							
Kabirdham	Bhikuria-chhanta	1:4000	4.0	10	320.0	235	G2 stage general exploration for limestone was carried out in Bhikuria-Chhanta block. Ten vertical boreholes at 400 m x 400 m of grid pattern were drilled in the depth range of 30 m to 50 m for augmentation of resource. A few exposures of stromatolitic limestone were noticed in the eastern side of

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							the block and in the periphery of the study area, i.e., Birutola, Dhamki, Nawapara, Bhikuria and Sohagpur village. Limestone was intersected at depth ranging from 4.5 m to 14.35 m and the thickness of limestone was found to vary from 9 to 45.50 m. Silty shale intercalations/patches were seen intersected within the limestone. A total of 204 core samples and 05 bedrock samples were analysed for major oxides viz. SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, Na_2O, K_2O, P_2O_5, MnO, TiO_2, LOI. Besides, 10 petrochemical samples (PCS) were analysed for study of whole rock chemistry. Five XRD samples were also processed. Five water samples were also collected from the Bhikuria Chhanta block for analysis. For petrographic studies, 5 samples were collected and one sample was collected for beneficiation study. Study will continue in field season 2019-20.
Rajnandgaon	Sandi block	1:4000	5.6	34	550.1	995	G2 stage general exploration for limestone in Sandi block was carried out with an objective to assess limestone in this block. The block comprised stromatolitic limestone. stromatolitic rings vary in size from about 0.5 cm to about 10 cm in diameter. During exploration work, an area of 5.6 sq. km was covered by detailed mapping on 1:4,000 scale. Drilling was carried out in 34 boreholes in a grid pattern at an interval of 400 m that included 20 boreholes with an average depth of 35 m, 13 boreholes up to a depth of 60 m and one borehole up to a depth of 70 m in order to ascertain the thickness of limestone horizon in the area. Besides this, 05 BRS, 10 PCS, 05 XRD, 969 core samples, 06 water samples were collected and submitted for analysis. Chemical analysis results of core samples from 14

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							boreholes showed a wide range of variation in SiO_2 (5.69% to 64.16%), Al_2O_3 (0.79% to 17.13%), Fe_2O_3 (0.49% to 9.01%), CaO (0.32% to 50.19%), MgO (0.98% to 13.52%), and P_2O_5 (0.01% to <0.04%). The project will continue in field season 2019-20.
Gujarat							
Junagadh Limestone	Shepa, Sheriyakhan area, Mangrol Taluka	1:4000	5.4	30	1017.0	890	G2 stage general exploration for limestone suitable for steel melting shop/ cement grade and BF involved detailed mapping along with drilling boreholes in 400 m x 400 m grid pattern and collection of 870 powdered core samples, 10 samples each for XRD and thin sections. Limestone is the sole lithological unit exposed on the surface. Limestone and clay of Dwarka and Gaj Formation have been intersected in boreholes. Preliminary chemical analysis suggests that both limestone and yellowish calcareous clay satisfy the criteria for cement grade limestone. The most of the survey area was covered by limestone of Miliolite Formation. The average thickness of Miliolite Formation was 5 m in subsurface with maximum thickness of 15 m observed in 2 boreholes. The Dwarka Formation was seen represented by both limestone and calcareous clay. The Dwarka clays showed colours ranging from light grey to greenish grey while limestone was brown coloured, highly fossiliferous; the fossils were highly recrystallised (shells are replaced by silica) and were only observed in core samples. In all the boreholes, the limestone of Miliolite Formation was seen followed by the intersection of Dwarka Formation.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Jammu & Kashmir							
Rajouri	Darhal-Lah area	1:12500 1:4000	50.0 1.2	-	-	-	G4 stage reconnaissance survey for limestone was taken up in Darhal–Lah area with an objective to delineate the occurrence and establish the disposition of limestone bands and to assess the potentiality of limestone for industrial use. The Baila limestone of Parautochthonous zone was the target for limestone. The average width of limestone band was observed to be about 40 m. The Baila limestone was found to extend for a strike length of about 9 km in study area and in basal part, limestone was seen to have less shale parting as compared to top part.
Karnataka							
Kalaburagi	NE of Ravur	1:4000	7.1	20	877.0	709	G3 stage preliminary exploration for limestone was carried out in Northeast of Ravur area. The lithounits in exploration area were mainly limestones. The bedrock samples were micritic and were mainly composed of calcite as major mineral and quartz as minor mineral. The chemical analysis of bedrock samples indicated Portland and Blendable Cement grade limestone. All the boreholes were drilled at 650-700 m x 600 m grid intervals and up to 40 m depth, except one borehole. Drilling data indicated that limestone beds lay below 0.6 to 4.0 m of thick overburden soil. From top to bottom, the lithounits consisted of light grey limestone unit with a thin stylolitic and glauconitic limestone horizon, grey stylolitic limestone, light grey limestone with thin shale intercalation and chocolate brown intercalated limestone and shale. Specks of pyrite and glauconite were noted in split cores. The Rabanpalli Formation of about 27 m thickness in the area

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							comprised purple and green shale. The analytical results indicated that the grey stylolitic limestone unit is generally Blast Furnace (BF) grade; whereas, the light grey limestone horizon is of Blendable and Portland Cement (PC) grades. The quality of limestone gradually deteriorates with increasing shale lamellae. The analytical results of Borehole no. 02 indicated PC grade limestone from 2.60 to 5.50 m depth followed by BF grade from 5.50 to 29.50 m, PC from 29.50 to 32.50 m and Blendable Beneficiable cement (BBC) grade from 32.50 to 38.45 m. The Borehole no. 03 revealed BBC Grade limestone from 0.6 m to 1.5 m depth, PC from 1.5 m to 3.00 m, BF from 3.00 m to 27.00 m, PC from 27.00 to 28.50 m and BBC from 28.50 to 34.25 m. The Borehole no. 05 indicated BBC from 1.0 to 9.0 m depth followed by BF from 9.0 to 37.0 m and BBC from 37.0 to 40.0 m. The borehole KGR-06 also revealed BBC from 1.5 to 11.0 m depth followed by BF from 11.0 to 37.0 m and PC from 37.0 to 40.0 m. It is observed in the analysis of core samples of 4 boreholes that the thickness of BF grade limestone unit is more than 20 m. The resources of explored block has been approximately estimated at 380 million tonnes of BF grade limestone and approximately 450 million tonnes of cement grade limestone within 40 m depth range. The average grade of limestone resource and tonnage can be ascertained after the receipt of analysis of all the core samples. The project will continue in field season 2019-2020.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Kalaburagi	South of Chittapur	-	-	18	733.0	583	Based on the earlier work in the area, the block of 3.6 sq. km was proposed for G3 stage preliminary exploration to find out the potential for limestone resources. The thickness of the Sedam limestone member having grey limestone and grey glauconitic limestone bands was about 22 m to 30 m and of inferior grade. The grey limestone can be used as a blending material in cement industries. This unit was found to be followed by the stylolitic limestone (Wadi Limestone) from an average depth of 25 m to 30 m. There were two stylolitic limestone units, i.e. upper and lower stylolitic limestone. Upper stylolitic unit was of limited thickness of 5 to 10 m and the lower one was of 25 to 30 m thickness. This limestone was found to be of economic significance due to its high grade and can be of use in the production of Portland cement and may also qualify for flux grade. The study will continue in next field season 2019-20.
Madhya Pradesh GSI							
Katni & Satna	Jamuwanikala block & Bhatia limestone block	1:4000	0.48	12	644.15	-	G2 stage general exploration for limestone and bauxite involved detailed mapping of 0.48 sq. km on 1:4,000 scale at both Jamuwanikala and Bhatia limestone blocks with drilling (644.15 m) and other connected sampling. Jamuwanikala block for limestone and bauxite covered an area of about 0.23 sq. km. In this block, 4 boreholes was drilled to a cumulative depth of 304.05 m. Jamuwanikala block was seen to be represented by grey-bluish to grey coloured, well-bedded limestone intercalated with shale. The southern margin of the block was represented by Rohtashgarh limestone. A total of 8 boreholes were drilled to a cumulative depth Contd

Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							of 340.10 m in Bhatia limestone block (0.25 sq. km). Bhatia block was seen to be mainly represented by light gray-dark gray, moderately hard, fractured and stromatolitic limestone. Carbonate vein of 0.5-1 cm was seen to be present at various depths.
Maharashtra Limestone							
Chandrapur	Janguguda	1:50000 1:5000	1.00- 0.18	11	942.5.50	-	Objective of the exploration was to continue the exploration of limestone deposit present near the Janguguda area in details.The Limestone-bearing zones are lenticular in shape with the dominant strike towards NW. The limestone strikes NWW-SEE with varying dip from 200-300° due SW however in some places it is almost vertical.
	Khirdi-	1:50000 1:5000	2.90 1.47	2	276.5	29	Objective of the exploration was to explore limestone deposit with the extension in detail near Village Khirdi. The limestone bearing zones are lenticular in shape with the dominant strike towards NW. The limestone strikes NWW-SEE with varying dip from 200-300° due SW however in some places it is almost vertical.
Chandrapur	Ruyad-Aheri	1:50000	15.43	6	336.0	-	Objective of the exploration was to continue the exploration of limestone deposit present near the Ruyad-Aheri area in details. The block geology is dominated by Penganga Group of Meso to Neo Proterozoic in age. The limestone occurs as thin, linear or curvilinear bands within Satnala shale with faulted contact forming synclinorium. The limestone exposed on the surface is intercalated with thin marl bands, dolomitic bands and thin argillaceous/mudstones which are calcareous in nature.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Yavatmal	Adegaon-Yedad	1:25000	15	48	4548.68	2994	Objective of the exploration was to delineate the limestone deposit & to calculate the reserves/ resources of limestone. In the field season 2017-18, a total of 14 sq.km area were covered under reconnaitory mapping during which a total of 91 grab samples were collected. Analytical results of all 91 grab samples received, show CaO % ranging from 21.20 % to 54.9 %; MgO from 0.82 % to 20.74 % and SiO_2 ranging from 1.33% to 30.03 %. The area was taken for further prospecting to cover the area in G3 level as per Framework guidelines (UNFC) during the FS 2018-19. The Penganga Group of rocks that comprise dark gray limestone, dolomite, shaly limestone and shale trending NE-SW to N-S direction with varying dips of 5°-10° due west to SW, show that the area is intensely folded. about 48 boreholes were completed during the field season 2018-19 with 4,548.68 m of drilling. Out of 48 boreholes, analytical results of 24 boreholes have been received and the average grade was calculated. On the basis of results it is observed that CaO, MgO and SiO_2 content for limestone ranges from 34.00-46.73%, 1.22-4.49% and 4.58-24.16% respectively.
Yavatmal	Borgaon-Khandala	-	-	11	778.50	554	The limestone occurring in the area is associated with dolomite and dolomitic limestone belonging to Penganaga group of Precambrian Age trending N30°W-S30°E with a dip of 10° to 20° due west. Boargaon-Khandla block seems to be North-west extension of Kurai and Kurli area. During the field season 2018-19, a total of 11 boreholes were drilled with

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							total drilling of 778.50 m. Thus in all a total 34 of boreholes were drilled (FS 2017-18 & 2018-19) and core sample were collected and sent for chemical analysis. Core samples of limestone were analysed to have CaO and MgO ranging from 34.10 to 47.10% and 2.14 to 8.17% respectively. While SiO_2 ranged from 7.15 to 22.14%. The strike length of limestone in the area is about 2.50 km and its width ranged from 300 m to 600 m. The width of limestone belt is about 300 m and towards northern portion of the block the limestone is low grade (CaO 26.60 to 29.60% and MgO 6.21 to 14.01%).
Yavatmal	Kurai block	-	-	5	517.0	505	Objective of the exploration was to delineate the limestone deposit & to calculate the reserves/resources of limestone. 1. The Velabai – Kurai belt is about 20 km SSE of Wani town. The investigated belt is about 5.5 km in strike length from East of Velabai to East of Kurai and has width varying from 2 to 2.5 km. The limestone bands are observed alternately with dolomite. The general strike of the limestone and dolomite bands is N 30p W – S 30p E with dips varying from 10^{o} to 30^{o} towards SW. The limestone band range in length from 600 to a kilometer and have a width range of 10 m to 40 m. The thickness of limestone beds in these bands ranges from 01 to 15 m.
Yavatmal	Kurli block	-	-	7	448.50	270	Objective of the exploration was to delineate the limestone deposit & to calculate the reserves/resources of limestone. The investigated belt is about 5.5 km in strike length from East of Velabai to East of Kurai and has width varying from 2 to 2.5 km. The limestone bands are

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							observed alternately with dolomite .The general strike of the limestone and dolomite bands is N 30° W – S 30° E with dips varying from 10° to 30° towards SW. The limestone band range in length from 600 m to a kilometer and have a width range of 10 m to 40 m. The thickness of limestone beds in these bands ranges from 01 to 15 m.
Meghalaya							
East Jaintia Hills	Akshe block Litang valley	1:4000	2.8	6	810.0	-	G3 stage preliminary exploration for limestone was carried out to assess the resource of different grades of limestone. The Upper Sylhet limestone which was the target horizon for exploration has an average thickness of 108.12 m. The limestone grade was mostly of Cement grade (portland & blendeble) with minor amounts of SMS (OH) grade.During detailed mapping, two litho units, namely, grey fossiliferous limestone of the Upper Sylhet Limestone and shale-sandstone-marl were observed in the block. It was observed that in all the core logs the limestone is fossiliferous, massive, indurated and ferruginous towards the upper part, while at the bottom part, it is grey to buff coloured.
Meghalaya							
East Jaintia Hills	North Pala block Litang valley	-	-	12	1164.95	473	With an objective to make systematic assessment of grade-wise reserves/resources for Prang limestone of Shella Formation, a G-3 stage preliminary exploration in North Pala block was started in the field season 2016-17 and continued in the subsequent seasen. In north Pala block, detailed mapping of 3 sq. km was carried out on 1:4,000 scale in field season 2016-17 and FS 2017-18. The work carried out in field season 2018-19 included exploratory drilling of 1,164.95 m in 12 boreholes drilled on grid pattern and 439 core samples and 34 check samples were

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							collected to evaluate the grade of limestone and to estimate the grade-wise resources for the block. Spacing of boreholes grid was fixed approximately at 500 m along the strike and 450 m along the dip. The exploratory drilling carried out in North Pala block revealed the presence of a very thick (average thickness 81.33 m), grey coloured, medium-grained,highly fossiliferous limestone band. The XRF analytical result for 271 primary core samples of six boreholes indicated that the limestone contained CaO ranging from 28.33% to 51.43% (Avg. 42.59%), MgO from 1.17% to 3.49% (Avg. 1.98%), Al_2O_3 from 1.21% to 10.52% (Avg. 4.39%), Fe_2O_3 from 0.86% to 17.04% (Avg. 4.01%) and SiO_2 from 2.57% to 18.70% (Avg. 8.09%). Though limestone asseyed higher value of CaO but due to higher silica percentage, it is said to constitute cement grade with subordinate SMS grade limestone.
East Jaintia Hills	SE of Akshe Litang valley	1:4000	3.0	6	799.95	350	A G3 stage preliminary exploration for limestone was carried out in south east of Akshe, Litang Valley. The major rocks exposed in the area were sandstone, shale, marl and Upper Sylhet Limestone. The upper sylhet limestone is mainly exposed in the northern, south-eastern and southwestern part of the area which is light grey to dark grey colored, hard, massive and is highly fossiliferous. The thickness of upper sylhet limestone intersected in the boreholes varied from 38.37 to 120.58 m. Out of 350 core samples sent for analysis, results of 136 samples were received.
Rajasthan							
Jaisalmer	Bharmal ki Tekri block	-	-	23	910.0	242	During G2 satge general exploration for SMS/Cement grade limestone in the

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							Bharmal Ki Tekri block, boreholes were drilled to a depth ranging 40±10 m at 400 m grid interval and 6 XRD samples, 6 thin section samples, 211 core samples and 19 geotechnical samples were collected. Three types of limestone were intersected in the boreholes, i.e., hard and compact limestone of Khuiala Formation, chalky limestone and impure clayey limestone. The lithology intersected in the boreholes was found to have a few meters of soil cover/ loose sand/limestone stone fragments followed by a good thickness of limestone within depth of 0 m to 16 m with width ranging from 3 m to 9 m while the impure clayey limestone of 4 m to 16 m was reported at depth range of 6 m to 34 m followed by variegated clay unit ranging from 35 m to 40 m. The study will continue in field season 2019-20.
Jaisalmer	Kamiyon ki Beri block	-	-	32	1320.0	817	G2 stage general exploration for SMS/cement grade limestone was carried out in the Kamiyon Ki Beri block. During the investigation, vertical boreholes were drilled with depth upto 40±10 m at 400 m grid interval. Mainly three types of limestone, i.e., hard and compact limestone of Khuiala Formation, chalky limestone and impure clayey limestone were intersected in the boreholes. The hard and compact limestone of Khuiala Formation with maximum thickness of 11 m was intersected, chalky limestone thickness in individual borehole ranged (cumulative) from 1 m to 12 m within depth range of 5 m to 27 m, thickness of impure clayey limestone in individual borehole ranged (cumulative) from 3 m to 22 m within depth range of 6 m to 49 m and variegated clay thickness in individual borehole ranged

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							from 2 m to 16 m within depth range of 18 m to 40 m. The study will continue in next field season 2019-20.
Jaisalmer	Sakar ki Dhani block	-	-	29	1250.0	883	G3 stage preliminary exploration for low silica SMS/cement-grade limestone comprised drilling of 29 boreholes to depth ranging upto 40±10 m at 400 m grid interval. Three types of limestone i.e. hard and compact limestone, chalky limestone and impure clayey limestone of significant thickness were intersected in the boreholes. The study of cores log indicated different varieties of limestone which include hard and compact limestone with thickness ranging from 7 to 23 m within depth range of 0 to 30 m, chalky limestone with thickness ranging from 3 to 14 m within depth range of 10 to 35 m and impure clayey limestone with thickness ranges from 3 to 18 m within depth ranging of 9 to 35 m. The exploration will continue in field season 2019-20.
Tamil Nadu							
Ariyalur	Puthuppalayam & Periyathirukonam block	1:4000	3.1	18	633.4	-	G2 stage general exploration for cement-grade limestone involved detailed mapping of 2.10 sq.km area in Puthuppalayam block and 1.0 sq.km area in Periyathirukonam block. Limestone found to occur in Puduppalayam and Periyathirukonam areas was generally yellow colour, hard and compact with abundance of shells. The presence of abundant shells and the calcareous binding medium classifies the limestone to be cement

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							grade. A total of 15 vertical boreholes have been drilled for a cumulative drilling meterage of 491.35 m in Puthupalaiyam block. The limestone band of Kallankurichi Formation occurs at a depth of 0.90 m to 16.00 m below the ground level and up to the depth of 54.00 m. Thickness vary between 2.10 m and 33.00 m. Intercalations of calcareous sandstone were encountered at places. It is observed that the thickness of the limestone increases towards east and north while it appears to thin out to 0.30 m towards south. Analytical results indicated the CaO content varying from 41.01 to 53%. In Periyathirukonam block, three boreholes have been completed to a cumulative depth of 142 m. The limestone thickness ranged from 14.25 m to 34.75 m and the overburden ranged from 30.85 to 39.0 m. The study will continue in field season 2019-20.
Virudhunagar & Theothukudi	Vellayapuram block	1:12500 1:4000	100.0 5.0	-	-	-	G4 stage reconnaissance survey for cement-grade limestone was taken up in Vellayapuram block. The exploration comprised large-scale mapping, detailed mapping and pitting & trenching. The crystalline limestone band of Ayan Karisalkulam (AK) block extends for a strike length of 1.8 km with average width of 4 m and is white to dirty white in colour. It is medium-grained with sarcoid texture and consists of calcite (80-85%). The thickness of the limestone band varies from place to place. The chemical results of the AK band yielded CaO content 47 %, Fe_2O_3 1.5%, MgO 3.6% and Si_2O_3 10%. In Mettilpatti block, a few thin calc-granulite bands as compared to AK band were

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							delineated with strike length of 30 to 200 m and average width of 0.5 to 2.5 m. The chemical analysis of these bands showed average CaO content of 33%, Fe_2O_3 - 3.2%, MgO - 2.8% and Si_2O_3 - 18%.
MECL							
Limestone							
Chhattisgarh							
Raipur	Nahardih-Madhaipur block	1:10000	5.45	34	1467.00	1591	The resources estimated were at 77.84 million tonnes with 43.50% CaO, 1.71% MgO, 10.96% SiO_2,2.75% Al_2O_3, 1.54% Fe_2O_3 & 36.79% LOI under UNFC code 332.
Rajasthan							
Jhunjhunu	Gothra-, Parasrampur east block, Nawalgarh tehsil	1:5000	4.78	19	1568.50	616	The net in situ resources estimated was at about 160.76 million tonnes with an average grade of 48.46% CaO, 2.05% MgO, 6.89% SiO_2, 2.26% Al_2O_3, 1.17% Fe_2O_3 & 38.04% LOI under UNFC code 332.
	Gothra-Parasrampur west block, Nawalgarh tehsil	1:5000	2.88	14	1229.00	567	The net in situ cement-grade limestone resources estimated was at about 158.72 million tonnes with an average chemical composition of 49.56% CaO, 1.38% MgO, 6.08% SiO_2, 2.04% Al_2O_3, 1.08% Fe_2O_3 & 38.85% LOI under UNFC code 333.
Potash							
Rajasthan							
Bikaner	Jaitpur block	1:5000	29.115	7	5279.50	7238	The gross resources at 3% K cut-off has been estimated at 10.698 million tonnes and net resources of 8.55 million tonnes with average 4.42% K. Similarly 29.458 million tonnes of gross resources and 23.56 million tonnes of net resources with average grade of 2.983% K at 2% K cut-off and 92.756 million tonnes of gross resources and 74.20 million tonnes of net resources with average grade of 1.842% K at 1% K cut-off were estimated separately. The Potash resources have been estimated for 12.594 sq.km out of 19.41 sq.km

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							explored area of Jaitpur block having 29.115 sq.km area. A total of 17,905.47 million tonnes of halite resources have been estimated with 35.30% Na over an area of 19.41 sq. km area.
Commissioner of Geology & Mining, Gujarat							
Limestone							
Dwarka	Devbhume, Dwarka	-	-	12	495.00	104	Objective of the exploration over an area of about 36.86 ha was taken up with an objective to identify auctionable block. Resource estimation is under process.
Junagadh	Junagadh	-	-	18	905.00	91	Objective of the exploration over an area of about 24.65 ha was taken up with an objective to identify auctionable block. Resource estimation is under process.
Gir Somnath	Gir Somnath	-	-	85	2879.50	393	Objective of the exploration over an area of about 150.00 ha was taken up with an objective to identify auctionable block. Resource estimation is under process.
China clay							
Kachchh	Kachchh	-	-	37	3071.00	-	Objective of the exploration over an area of about 168.90 ha was taken up with an objective to identify auctionable block. Resource estimation is under process.
Bentonite							
Kachchh	Kachchh	-	-	11	574.60	-	Objective of the exploration over an area of about 250.00 ha was taken up with an objective to identify auctionable block. Resource estimation is under process.
Directorate of Mines & Geology, Rajasthan							
Limestone							
Kota	N/v Nimana-Dunia, Shohan Khera, Tehsil Ramganjmandi.	1:10000 1:4000	16.00 3.50	4	128.00	52	The exploration was taken up to assess cement-grade limestone in the area. The progressive inferred geological resources estimated were at 17.21 million tonnes of

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							marginal cement-grade limestone and that of kota stone were 29.59 million tonnes Exploration will continue.
Baran	N/v Aughar,Tanda, Majhola Bhagwanpura and Thana Kasba, Tehsil Shahabad.	1:10000 1:4000	10.00 3.30	-	-	10	-
Sandstone							
Baran	Aama and Khan ki Jhonpariya, Tehsil Anta.	1:4000	1.20	-	-	-	The exploration was taken up to identify sandstone suitable for masonry purpose.
Limestone							
Karauli	N/v Hansapur, Gota, Chichiri, Tehsil Mandrayal	1:10000 1:4000	30.00 5.00	-	-	-	Limestone was observed intermittently in 10 km x 40 m to 1500 m x 5–30 m area.
Naugar	N/v Deh Tehsil Jayal	1:10000	20.00	7	297	121	Cement-grade limestone resources of indicated category estimated were at about 175.84 million tonnes. Exploration will continue.
	N/v Awad & Khera Tehsil Jayal	1:10000	15.00	2	61.5	4	Cement-grade limestone resources of Indicated category estimated were at about19.20 million tonnes. Exploration will continue.
	N/v Tadas & Khorwa, Tehsil Khinswar	1:10000	5.00	-	-	3	Exploration will continue.
Sandstone & Masonry stone							
Karauli	Aama and Khan ki Jhonpariya, Tehsil Anta.	1:10000 1:4000	10.00 2.70	-	-	-	-
Chittorgarh	Samriya Kalan, Nalhuramji Ka Khera, Meghniwas and Mandna Begun-Taluka.	1:10000 1:4000	10.00 3.00	-	303.00	263	The limestone mapped in the area was of strike length 8.5 km and width of more than 2 km. The exploration will contiune. Reserves were not estimated.
	Sindwari, Ramakhera, Satkhanda Tehsil Begun.	1:10000 1:4000	10.00 3.00	-	107.00	34	Limestone with thin shale parting was encountered from 18.0 m to 50.0 m in one borehole. G2 level exploration will continue.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Red ochre, China clay, Silica sand, Marble, Quartz, Feldspar, etc.							
Chittorgarh	Purohiton ka Sanwata, Ramakheda, Rajoda, Tehsil Chittorgah Borda.	1: 4000	3.05	-	-	49	During exploration, five areas, i.e., Purohoton ka Sanwata north block (area 5.0 sq.km) - china clay, gravel, etc.; Purohoton ka Sanwata south block (area 1.6 sq.km), Ramakhewda block (area 1.6 sq. km) & Rajoda block (area 0.2 sq.km)- masonry stone; Borda block (area 0.25 sq.km) - china clay and masonry stone were identified.
Limestone							
Sirohi	Pindwara Tehsil	1:4000	1.00	4	184.00	172	Jharoli-Laj-Phulera-Nitaura limestone band was found intermittently extending for a strike length of more than 25 km with exposed width up to 300 m. The project was taken up in 2016-17.
Marble							
Sirohi	Reodar Tehsil.	1:10000 1:4000	25.00 2.00	-	-	04	-
Wollastonite							
Sirohi	N/v Positara, Aburoad Tehsil.	1:10000 1:4000	25.00 2.00	-	-	07	One isolated low lying exposure patch of length up to 40 m and exposed width up to 20 m was mapped. It consisted of quartz, calcite, garnet, calcitic marble, wollastonite, etc.
Blockable granite, Quartz-Feldsapr							
Rajsamand	N/v Anjana, Racheti, Hirakhera, Veena ka khera, Bacheriya.	1:10000 1:4000	30.0 4.0	-	-	-	-
Cement grade Limestone							
Bhilwara	N/v Chitauriya, Amartiya, Ratiya khera. Dhakarkhedi, Biharipura.	1:10000 1:4000	10.00 3.50	9	450.00	327	The limestone bands found intermittently were mapped for a strike length of 12.5 km with width varying from 2 to 2.5 km. The pink/ purplish limestone constitutes the lower bed while the gray limestone form the upper part.
Quartz, Feldspar, Mica, Dolomite and other economic minerals							
Bhilwara	N/v Kosital, Raipur Khas, Siyar, Nathriyas,	1:4000	2.05	-	-	2	Resources are yet to be estimated.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Limestone							
Banswara	N/v Parthipura, Nayatalab, etc.	1:4000	5.00	-	-	150	About 3.5 km long medium to coarse-grained, crystalline pink to white coloured limestone with width varying from 100 m to one km has been identified.
Limestone & Dolomite							
Pratapgarh	Devlapal, Bhungabhat, Tehsil Dhariyawad	1:10000 1:4000	20.00 3.00	-	-	27	Limestone has been exposed intermittently for about 4 km. The entire area that has been exposed comprises. dolomite and minor soapstone.
Limestone							
Dholpur	N/v Gulawali, Sumerpur, etc. Tehsil Bari & N/v Kamre ka pura, Maroli-Rajai, Sagarpada, etc.	1:10000	22.00	-	-	-	Limestone has been exposed close to River Chamble. The project is set to continue.
Sandstone							
Dholpur	N/v Naksoda Sanora, Tehsil Bari and N/v Tajpur, Nandanpur, Tilua, Tehsil Basedi	1:10000 1:4000	10.0 2.0	-	-	-	-
Limestone							
Dungarpur	Munger, Barwasa, Sabla, etc. N/v Kopra, Bhimdari, Tehsil Sagwara.	1:4000	1.00	-	-	-	Light coloured fine to medium-grained limestone, at places hard and compact crystalline marble band were mapped n/v Kopra for about 1,200 m strike length with an average width of 32 m to 120 m.
Decorative stone							
Dungarpur	Rohanwara, Manpur, Sarkan, Mandwa, Dewal, Karoli, Hathod, Nalwa,	1:10000 1:4000	20.00 2.00	-	-	-	-
Limestone							
Ajmer	N/v Shyamgarh Pakriyawas, Kanakheda, Kesarpura , Shivpurghata, etc. Tehsil Beawar.	1:4000	3.00	-	-	07	Four limestone bands of dimension varying from 920 - 1,550 m x 80-550 m have been mapped.
Jaipur & Alwar	N/v Bithloda, Mandha, Bhankri, Karoi, Nayabas, etc. Tehsil Beawar.	1:4000	2.00	-	-	03	-

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Sikar	Maonda, Tehsil Neem ka Thana.	1:10000 1:4000	10.00 3.20	-	-	24	-
Jodhpur	N/v Bhagasani & Rampurya Tehsil Bilara	1:10000 1:4000	20.00 5.00	-	-	50	-
Bikaner & Nagaur	N/v Bhundel & Mandeliya Tehsil Khinwsar & Nokha	1:4000	5.00	-	-	21	Exploration will continue.
Pali	N/v Veerampura ki Bhagal, Thandiberi & Reliya Tehsil Bali	1:4000	3.00	-	-	20	-
Jaisalmer	N/v Sam	1:10000 1:4000	15.00 2.00	17	721.00	208	Resources of Chalky limestone (cement-grade) were estimated at about 181.0 million tonnes and hard compact bouldery (SMS grade) limestone at about 74 million tonnes.
Jaisalmer	N/v Jajiya/ Padhardi ki dhani	1:10000 1:4000	20.00 5.00	17	721.00	-	-
Granite & Masonry stone							
Jalore	N/v Bagra, Maylawas, Nabi, Tehsil Akoli	1:10000 1:4000	10.00 3.00	-	-	09	-
Directorate of Geology, Odisha							
Limestone							
Odisha							
Bolangir	Telipadar	1:2000	1.10	29	773.00	338	Thickness of limestone varies from 5.4 m to 34.88 m. Limestone extends over a length of 1,114.0 m with width 1,064.0 m. A total of 288.39 million tonnes of hard crystalline limestone were encountered in 16 boreholes. Exploration will continue.
Quartz & Quartzite							
Mayurbhanj	Bhataubeda-Chiringdihi	1:4000	0.51	-	-	22	Out of the 7 discontinuous quartz bodies demarcated during study, 4 quartz exposes are promising. Chemical analysis of 18 veins quartz samples indicate SiO_2 percentage varying from 99.026 to 99.90.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Graphite							
Bargarh	Temrimal (I & II) & Dahigaon	1:10000	1.41	-	-	-	Geophysical survey comprised SP survey of 1.41 sq.km area and two numbers of vertical electrical sounding were carried out in the area. Anomalous zone of causative bodies have been interpreted for further exploration.
Dhenkanal	Karabira	1:2000	0.50	6	150.30	43	The cumulative thickness of graphite mineralisation is 30.20 m as encountered in 5 boreholes and fixed carbon content varies from 0.24 % to 13.94%.
Rayagada	Jagdalpur	1:2000	0.297	48	1070.00	309	The thickness of ore zone varies from 1.20 m to 23.70 m. Resources estimated were at 0.981 million tonnes at (+) 2% FC.
	Sargiguda	1::2000	0.517	5	100.20	20	The thickness of ore zone varies from 4.75 m to 9.80 m. Exploration suspended due to inhostile terrain.
Decorative Stone of Artisan grade							
Cuttack, Jajpur, Balasore, Mayurbhanj & Keonjhar	Parts of Cuttack, Jajpur, Balasore, Mayurbhanj & Keonjhar	1:50,000 1:5000	70.0 1.661	-	-	52	Six potential decorative stone occurrences were identified, i.e., (i) Govindpur :750 m x 275 m in Cuttack; (ii) Teligarh : 740 m x 520 m, (iii) Bandareswar : 1,500 m x 600 m & (iv) Chandia : 200 m x 200 m in Jajpur; (v) Siarhimlia 750 m x 650 m in Keonjhar and (vi) Nedam 740 m x 255 m in Mayurbhanj districts.
Decorative Stone and other minor minerals							
Gajapati	Ramagiri & Mahendragada	1:25000 1:4000	240.00 0.45	-	-	37	Three decorative/dimension stone blocks have been identified, i.e., Lausahi (450 m x 190 m), Jhadapada (320 m x 215 m), Nuagan (560 m x 210 m). Besides, two construction grade building materials have also been identified, i.e., Khajuridiha road metal (326 m x 145 m) and Laxmipur road metal (200 m x 66 m).
Quarzite							
Keonjhar	Ramanguda in Champua Sub-division	1:4000	0.51	-	-	49	The length of quartzite body is 1,010 m with width varying from 40 m to 90

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							m.Chemical analysis of quartzite samples revealed that SiO_2 percentage varies from 98.06 to 99.76% and Fe_2O_3 percentage varies from 0.24 to 0.80%.
China clay							
Mayurbhanj	Dumuria	1:2000	0.5	47	1004.00	939	China clay/Kaolin occurs as lenses/pockets of different sizes and shapes below a thin soil cover and laterite of average thickness 2.5 m. The total cumulative thickness of clay is about 562.16 m. Exploration is in progress.
DGM, Chhattisgarh							
Limestone							
Bhatapara-Balodabazar	Sarseni-Guma area	1:50000 1:4000	220.00 2.34	20	1096.50	1040	The tentative resources were estimated at about 180.47 million tonnes. Investigation will continue.
Raigarh	Khairaha block Sarangarh tehsil	1:4000	5.00	8	150.70	98	The Inferred category resources has been estimated at about 68.80 million tonnes which includes 18.40 million tonnes of cement grade (CaO >44%) and 50.40 million tonnes of cement (beneficiable/ blendable) grade (CaO 38% to 41%).
	Kamardih block,	1:4000	5.25	11	274.00	132	The Inferred category resources has been estimated at about 107.59 million tonnes which includes 28.49 million tonnes of cement grade (CaO >44%) and 79.10 million tonnes of cement (beneficiable /blendable) grade (CaO 38% to 41%).
Bastar	Ichhapur area	1:4000	2.07	28	1122.00	326	The mineralised area for limestone extends for a strike length of 1.5 km and depth peristence was recorded for a drilled depth of 54.00 m. The total tentative resources estimated in the area is about 120.00 million tonnes . G3 level exploration has been completed.
DGM, Uttar Pradesh							
Barytes							
Lalitpur	Mathara-Dang area	1:12,500	60.00	-	-	65	A G4 level exploration comprising digging of 6 pits of dimension 2 m x 2 m x 2.5 m and excavation of 2

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							trenches of dimension 7 m x 1 m x 1.5 m and 5 m x 1 m x 1.5 m were carried out. The strike length of 7.00 km was covered to explore barytes in the area. Minor barytes occurrences in the form of veins were encountered at 1.3 m depth in Shahariyapura. Base metals sulphides were observed in dolorite and granodiorite with gold value varying from 0.17 ppm to 0.31 ppm.
Rock phosphate							
Lalitpur	Semarkhera, Tori & Pisnari	1:1000	0.50	-	-	104	A G3 level exploration was carried out in selected area of the eastern block-V. The exploration comprised geological mapping, 10 nos trenching and sample collection. Drilling will be taken up to know the grade and quantity of mineral available in the area after getting forest clearance.
Dimensional stone							
Lalitpur	Northern & some southern part of Latitpur	1:50000	50.00	-	-	-	Different varities of dimension stone in 19 new blocks aggregating 170 acres area have been identified.
MECL							
Dunite							
Tamil Nadu							
Namakkal & Tiruchirapalli	Andipatti-Jambumadai-Urakari sector	1:12500	125.00	-	-	143	The dunite samples shows mean value of 1,079.33 ppm on Ni and mean value of pyroxinite samples is 124.66 ppm of nickel. The analytical results indicated that the unltramafics particularly dunite is enriched with high Ni value, i.e., average 1,079 ppm and pyroxinite & dunite are slightly enriched with chromium values. Analytical results for PGE values are not encouraging as average total values in ultramafics, i.e., pyroxinite & dunite are 149.09 ppb (Pt+Pd - 130.43 ppb). Resources have not been estimated.
Andalusite							
Jharkhand & Uttar Pradesh							
Garhwa & Sonbhadra	Nagar-Untari and adjoining areas	1:12500	100.00	-	-	35	The content of andalusite in the rock varies from 5.38% to 22.78% by weight. The total possible resources estimated by

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							isochore method per 1 m and 5 m depth are about 11.80 million tonnes and 58.99 million tonnes, respectively.
Barium, Gold, Silver, Copper, Lead & Tungsten							
Maharashtra							
Nanded	Aurala-Sawali block	1:12500	100.00	-	-	444	No evidence of direct mineralisation were noticed as most of the area is covered by black cotton soil. Outcrops of granite are also devoid of any mineralisation. Except for high Ba values reported from dug well situated north of Kotala and Aurala and in areas near Village Torna, the rest of the area on analysis of bedrock, stream and soil samples indicate poor mineralisation for barium. The geochemical analysis results for Cu, Pb, Au, Ag & tungsten showed very discouraging results.
Directorate of Mines & Geology, Telangana							
Limestone							
Suryapet	Cluster -1, Mellacheruvu block	1:125000	63.51	-	-	157	G4 stage exploration in the area was taken up under NMET fund.
	Cluster -2, Mettampalli block	1:125000	16.07	-	-	60	G4 stage exploration in the area was taken up under NMET fund.
	Cluster -3, Raghunathpuram	1:125000	51.10	-	-	179	G4 stage exploration in the area was taken up under NMET fund.
	Cluster -5, Ramapuram	1:125000	61.37	-	-	36	G4 stage exploration in the area was taken up under NMET fund.
	Cluster -6, Dondapadu	1:125000	51.40	-	-	88	G4 stage exploration in the area was taken up under NMET fund.
Nalgonda	Cluster -4, Damarcherla	1:125000	19.86	-	-	52	G4 stage exploration in the area was taken up under NMET fund.
Vikarabad	Cluster -7, Jeewangi	1:125000	17.72	-	-	18	G4 stage exploration in the area was taken up under NMET fund.
	Cluster -8, Malkapur	1:125000	22.96	-	-	21	G4 stage exploration in the area was taken up under NMET fund.

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Table - 8 (Concld)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Suryapet	Sultanpur RF block, Mattampalli Mandal	1:5000	1.36	3	130.00	142	During G3 level exploration, a net in situ resources of 80.21 million tonnes were estimated under UNFC code 333.
	Pasupulabodu RF block, Nereducherlai Mandal	1:5000	1.39	3	108.00	95	During G3 level exploration, a net in situ resources of 41.68 million tonnes were estimated under UNFC code 333.
	Siadulnama RF block, Palakeedu Mandal	1:5000	1.70	3	127.00	136	During G3 level exploration, a net instu resources of 71.86 million tonnes were estimated under UNFC code 333.
Rashtriya Ispat Nigam Ltd							
Limestone							
Andhra Pradesh							
Krishna	Jaggayyapetta mine, Budawada village, Jaggayyapetta Mandal	-	12.95	83	4000.00	-	The tentative total geological resources has been estimated at about 900 million tonnes. The final reserves/resources estimation are in progress.
Dolomite							
Telangana							
Khammam	Madharam dolomite mine (384.46 ha), Madharam village, Karepally Taluka	-	-	20	1000.00	-	The tentative total geological resources has been estimated at about 80 million tonnes. The final reserves/resources estimation are in progress.
Quartz							
Andhra Pradesh							
Visakhapatnam	Kintada quartz mine (3.24 ha), Sy.No.153, Kintada village, K.Kotapadu Tahsil	-	-	-	-	5	Chip sampling carried out in lease area. The total geological resources available in the area is placed at 1.91 million tonnes.
Karnatraka State Mineral Corporation Ltd (Formerly MML)							
Magnesite & Dunite							
Karnataka							
Mysuru	Karya magnesite mine (ML 24.95 ha), Karya village, Nanjanguda Taluka	-	-	-	-	-	The exploration is carried out to know the depth and lateral persistence of magnesite for future mining. Based on earlier exploration, resources have been estimated at 1,82,135 tonnes of magnesite and 28,51,708 tonnes of dunite.
Clay							
Karnataka							
Hassan	Nandihalli mine (ML 2188A), Manjenahalli Kaval, N/v Nandihalli Asikere Taluka	-	-	-	-	-	The exploration is carried in the form of 13 trial pits. Clay resources have been estimated at about 624375 tonnes.