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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

Indira Bhavan, Civil Lines,
NAGPUR – 440 001

PHONE/FAX NO. (0712) 2565471
PBX : (0712) 2562649, 2560544, 2560648
E-MAIL : cme@ibm.gov.in
Website: www.ibm.gov.in

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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 2019-20.

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, etc.; plays the role of National Repository of mineral data through maintaining a databank 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.

Geographic information system and Remote sensing centre is functional in Indian Bureau of Mines since December 2018. Multi Mineral Lease-hold maps are now updated on Arc GIS platform. During the year 2019-20, vectorisation of 346 top sheets and plotting of 2,444 mining leases was completed and plotting of 1,807 leases were under progress. The geological layer for Goa, Maharashtra, Andhra Pradesh, Gujarat, Karnataka & Jharkhand and Forest Layer of Goa state was completed. Activity of plotting of PL and RP areas on ARCGIS platform was also under process.

Mineral beneficiation studies were carried out by IBM to encourage value addition, conservation and development of mineral resources. During 2019- 20, 47.75 ore dressing investigations, 24,633 chemical analyses, 2,811 mineralogical examinations and 03 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 triggers for major minerals and 130 triggers for minor minerals have been generated in second phase and these were sent to respective State Governments for field verification. So far, unauthorised mining in 5 cases of major minerals and 9 cases of minor minerals were confirmed by the State Governments.

IBM undertakes preparation of National Inventory of mineral resources on a quinquennial basis. Under this programme, implementation of UNFC system was adopted 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. The preparation and updation of NMI as on 01.04.2020 for 46 major minerals were under progress.

GSI

GSI pursued its most fundamental and basic mapping programme of systematic geological mapping in 2019-20 and had completed 17,467.5 sq. km Large-Scale Mapping, 273.4 sq.km detailed mapping and 1,32,805.7 m drilling as against previous year's achievement of 9,330.6 sq. km Large-Scale Mapping, 166.8 sq. km detailed mapping and 1,15,697 m drilling. Out of the total mappable areas of 3.146 million sq. km of the country, 31,19,080 sq. km was covered so far by systematic mapping bringing the total coverage to 99.15%. During field season 2019-20, no systematic geological mapping was carried out.

Resources Established

GSI has augmented in 2019-20 (till December 2019) coal resources of 5,135.03 million tonnes in various coalfields including Godavari Valley (Telangana), Pench Valley and Singrauli (M.P.), Tatapani-Ramkola and Mand Raigarh (Chhattisgarh), Ib River and Talcher (Odisha).

GSI has augmented 259.77 million tonnes of lignite resources in Ramnad sub-basin of Tamil Nadu in 2019-20 (till December, 2019).

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). The total EEZ coverage including TW is 20,05,073 sq. km out of a total EEZ area of 20,14,900 sq. km. During field session 2019-20, R V Samudra Ratnakar undertook multibeam bathymetry (11,848 lkm), bathymetry survey (13,499 lkm). An area of 24,444 sq km was covered by preliminary mineral investigation and close grid mineral investigation of 2,667 sq km was covered by Ratnakar and two coastal launches RV Samudra Shaudhikama and RV Samudra Kaustubh in the TW and EEZ of country.

The following marine geoscientific surveys were carried out during 2019-20 field season:

R V Samudra Ratnakar

Cruise- SR-052: Recconnoitary survey for lime mud in the continental shelf off Mumbai (Gap area Block-I).

Cruise-SR-053: Preliminary assessment of lime mud in the continental shelf off Porbandar (Block-I).

Cruise-SR-051: Regional exploration for polymetallic nodules off Lakshadweep Sea.

Cruise: SR-047: Search for Fe-Mn nodules off Lakshadweep Sea.

Cruise-SR-055: Preliminary assessment of phosphorite in the continental shelf off point Calimere, Tamil Nadu Coast.

Cruise-SR-056: Preliminary investigation for polymetals in the Fe-Mn crust/nodules in the southern part of west sewell ridge and regional search for polymetallic nodules in Sewell Rise, Andaman Sea.

Cruise-SR-057: Preliminary investigation for hydrothermal mineral resources in the northern part of Andaman Accretionary Prism (AAP), Bay of Bengal.

RV Samudra Kaustubh

Cruise-ST-272: Geophysical (Shallow Seismic) surveys within the territorial waters off point Calimere, Puducherry, Tamil Nadu and Off Ramayapatnam, Andhra Pradesh, Bay of Bengal.

Cruise-ST-275: Preliminary assessment of placer mineral resources in the territorial waters, east off Bhimunipatnam, Andhra Pradesh.

Cruise-ST-276: Preliminary assessment of placer mineral resources in the territorial waters off Rajapuram (South of Bavanapadu), North Andhra Pradesh Coast.

Cruise-ST-274: Preliminary assessment of placer mineral resource in the shelf area off Vizhunthamavadi, Nagapattinam District, Tamil Nadu.

Cruise-ST-278: Preliminary assessment of placer mineral resources in the territorial water off Chilka-Nuapara, Odisha Coast.

R V Samudra Shaudhikama

Cruise-SD-290: Multi-thematic mapping of contiguous zone beyond Territorial Water off Kozhikode, Kerala.

Cruise-SD-292: Preliminary search for heavy mineral resource in the inner shelf area off Anjengo, South Kerala.

Cruise-SD-293: Preliminary assessment of heavy mineral resources in the offshore sediments off Paravur (Block-IV), South Kerala.

Cruise-SD-294: Preliminary assessment of heavy mineral resources in the offshore sediments off Paravur (Block-III).

Cruise-SD-295: Preliminary assessment of heavy mineral resources in the offshore sediments off Kollam (Block-II), South Kerala.

Cruise-SD-296: Preliminary assessment of heavy mineral resources in the offshore sediments off Kollam (Block-I), South Kerala.

Cruise-SD-291: Multi-thematic mapping of the contiguous zone beyond territorial water off Tellicherry, Kerala.

Coastal Programmes and RP Items

Item No. 121: Sediment distribution pattern in the Pro-Delta Plain of Ganges - Brahmaputra delta, off West Bengal.

Item-123: Preliminary search for placer mineral resource in the nearshore area off Bavanapadu sector, North Andhra Pradesh Coast.

Item No. 125: Regional search for placer mineral occurrence in the nearshore area off coastal stretch between Vaippar and Vembar, Thoothukkudi District, Tamil Nadu.

Airborne Geological Survey

During 2019-20, one aero-geophysical surveys i.e. airborne magnetic & radiometric surveys by engaging Twin Otter Airborne Survey System (TOASS) over Banswara/Udaipur area, parts of Rajasthan and Madhya Pradesh was carried out to delineate mineral potential areas for detailed mineral investigation. The magnetic data distinctly brought out the domains/zones over the Archaean-Bhilwara supergroup towards northwest and southeast. The north-western part of the study area clearly brought out metavolcano-sedimentary sequence of Rajpura-Dariba, Pur-Banera and Debri Proterozoic fold basins. A small significant NNE-SSW trending linear high frequency magnetic anomaly (Target block-1) noticed NW of Hamirgarh may indicate gossan type of rocks important for potential sulphides mineralisation. The analysis of aerogeophysical data of Banswara-Udaipur area has revealed some significant potential areas for mineralisation. Based on the inference drawn from aeromagnetic signatures, spectrometric anomalies and geological evidences, four probable target areas were demarcated which are favourable for mineralisation. The NW-SE trending distinct linear high frequency magnetic signature (Target Block-2) noticed between south of Kapasan and NE of Menar adjacent to N-S trending Rajpura-Dariba fold belt located in close contact between the Hidoli group and Mangalwar complex is important in the point of view of minerals. The prominent NNW-SSE trending high frequency linear magnetic feature (Target Block-3) marked south of Dhariyawad need to be verified for sulphide mineralisation. A few discrete bullseye magnetic anomalies are proposed (Target Block-4) for probable Kimberlite signature. Since Kimberlites buried by Vindhyan plotformal sediments and they are intruded into Kaimur group of formations, a detailed geological and geophysical ground follow-up to be recommended to ascertain the mineral potential areas.

MECL

The highlights of exploration carried out by MECL during 2019-20 are summarised as below:

i) The Company has carried out about 6.39 lakh metre of exploratory drilling for various minerals, out of which 5.95 lakh metre were through departmental resources and about 0.44 lakh metre through outsourcing.

ii) A total of 223.42 sq.km area have been covered with detailed geological mapping for various minerals in different parts of the country. Besides, 3.84 lakh metre of borehole geophysical logging also were carried out.

iii) In laboratories, a total of 1,18,216 samples were analysed for chemical analysis and 867 samples for microscopic and petrographic studies.

iv) A total of 35 geological reports of mineral exploration, geophysical survey, environmental & remote sensing studies for different minerals were submitted which led to addition of 4,454 million tonnes of mineral resources during the year 2019-20.

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

- Bauxite - A total of 5.61 million tonnes of bauxite ore resources were established in Gumla & Lohardage districts in Jharkhand.
- Coal - A total of 2,122.91 million tonnes of coal resources were established in Mand Raigarh, Tatapani & Ramkola in Chhattisgarh.
- Copper - A total of 77.78 million tonnes of copper ore resources were estimated in East Singhbhum district in Jharkhand and Mayurbhanj district in Odisha.
- Lignite - A total of 366.48 million tonnes of lignite resources were established in Tamil Nadu.
- Limestone - A total of 1,809.46 million tonnes of limestone resources were estimated in Bilaspur district in Chhattisgarh, Kalaburagi district in Karnataka as well as Satna & Neemuch districts in Madhya Pradesh.
- Magnesite - About 10.05 million tonnes of magnesite resources were established in Udaipur & Rajsamand districts in Rajasthan.
- Manganese - A total of 0.96 million tonnes of manganese ore resources were established in Bolangir district, Odisha.
- Nickel - About 60.35 million tonnes of nickel ore resources were established in Namakkal and Tiruchirapalli districts, Tamil Nadu.

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 2019-20, ONGC has acquired 462.4 LKM of 2D seismic data, 2,449.6 SKM of 3D seismic data and drilled 106 exploratory wells (71 onland & 35 offshore). Out of these, 21 wells are oil bearing, 12 wells are gas bearing, 11 wells are under various stages of production testing, 26 wells are conclusively tested and 36 wells were declared as dry. ONGC made 12 discoveries in its operated nomination acreages. It has monetised 4 discoveries during the year.

During 2019-20, a cumulative of about 3,788 LKM of 2D seismic and about 7,018 SKM of 3D seismic have been acquired and 121 exploratory wells have been drilled amounting to a drilling meterage of about 340 thousand metres. The focus was on acquisition of data of offshore basins.

Ultimate reserves of oil and oil equivalent of gas (O+OEG) established by ONGC, OIL and Pvt./JVs as on 01.04.2020 are placed at 4,237.1 million tonnes. During 2019-20, accretion in ultimate reserve has been 73.5 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 2019-20 are furnished in Table -3.

Shale Gas

During 2019-20, ONGC has drilled two exclusive shale wells (NJSGA in Cambay Basin and MDSGA in KG Basin) and one dual objective well PGAE. At present, a dual objective well, LKEAA in KG Basin is under drilling. Out of the 29 wells completed so far, across four basins viz. Cambay, KG, Cauvery and A&AA Basins, 10 were exclusive wells and 19 were dual objective wells. Indications of presence of shale oil have been recorded in some wells i.e. JMSGA, NSGB and NJSGA in Cambay Basin and WGSGA in KG Basin. In the shale well, NGSGA (Cambay Basin), a zone encountered within the Nawagam Middle Pay (Tight Reservoir) was hydro-fractured and on activation, produced oil. The shale well WGSGA in KG Basin required further activation whereas another well GNSGC in Cambay Basin was awaiting hydro-fracturing. OIL Conventional core analysis of wells of 4 wells namely Dandewala-26, Sologuri-2, Matimekhena-5 and South Tinali-5 were completed. Final evaluation reports of Jaisalmer PML in Rajasthan and Dibrugarh Extn. PML,

Chabua PML, Dumduma PML in Assam incorporating the above conventional core results were submitted. Around 17 m of conventional core from well Balimara-6 of Dumduma PML was acquired for prospectivity evaluation of Barail shales. Two locations are identified in Jairampur Extn.

PEL and Deomali PEL for acquiring conventional core against the target shale of Upper Tikak Parbat and Disang shales for evaluation. Environmental Clearance was awaited.

Table - 1: Area wise Development of Wells & Meterage Drilled by ONGC, OIL & Private/ Joint Ventures/NOCs, 2019-20

Agency	Onshore		Offshore		Total	
	Wells (Numbers)	Meterage (in '000)	Wells (Numbers)	Meterage (in '000)	Wells (Numbers)	Meterage (in '000)
A. ONGC (Nomination)	273	515.76	79	176.82	352	692.58
B. OIL (Nomination)	25	65.04	-	-	25	65.04
C. Private/JVs/NOCs	129	253.12	20	53.91	149	307.03
Total	**427**	**833.93**	**99**	**230.73**	**526**	**1064.66**

Source: *Directorate General of Hydrocarbons Annual Report, 2019-20.*

Table - 2: Exploratory efforts by ONGC, OIL & Private/Joint Ventures/NOCs, 2019-20

Agency	Onshore		Offshore		Total	
	Wells (Numbers)	Meterage (in '000)	Wells (Numbers)	Meterage (in '000)	Wells (Numbers)	Meterage (in '000)
A. ONGC (Nomination)	71	204.46	27	74.73	98	279.19
B. OIL (Nomination)	11	30.79	-	-	11	30.79
C. Private/JVs/NOCs	2	6.70	10	23.46	12	30.16
Total	**84**	**241.95**	**37**	**98.19**	**121**	**340.13**

Source: *Directorate General of Hydrocarbons Annual Report, 2019-20.*

Table - 3: Oil & Gas Discoveries made by ONGC, OIL & Vedanta during 2019-20

Name of Basin	Well Name	Field/Block	Oil/Gas
A. ONGC			
Assam Arakan Basin	Sundulbari-12	ML-Sundulbari Agartala Dome	Gas
Assam Arakan Basin	Sundulbari-15	ML-West Tripura	Gas
Mumbai Offshore Basin	B-218-1	ML-Ext.NWMH	Oil
Mumbai Offshore Basin	R-12-6	ML-Ratna & R-Series	Oil
Mumbai Offshore Basin	B-219-1	ML-Ext.NWMH	Oil
Krishna-Godavari Onland	Nandigama North-1	ML-West Godavari	Gas
Krishna-Godavari Onland	Bilakurru-1	ML-Godavari Onland	Gas
Krishna-Godavari Offshore	YS-6-2 Sub	ML-Yanam	Gas
Cauvery Onland	Vanjiyur-3	ML-L-II	Oil
B. Oil India LTD.			
Assam Shelf	Dinjan-1	Tinsukia PML	Gas
Krishna-Godavari Onland	Yedurrulanka-1(YLK-1)	KG-ONN-2004/1	Gas
C. Vedanta (Cairn India)			
Assam Arakan Basin	Shakti-NE-1	RJ-ON-90/1	Oil

Source: *Directorate General of Hydrocarbons, Annual Report 2019-20.*

Coal

The agencies engaged in exploration for coal during 2019-20 were mainly GSI, CMPDI, SCCL, DGM Odisha and MECL.

GSI

In Bihar, a G2 level Gondwana coal exploration under thick Gangetic alluvium in Lakshmipur North block, northern extension of Hura Coalfield, Rajmahal Master Basin, Bhagalpur district was carried out. The investigation involved mapping of 7.0 sq km area on 1:10,000 scale, geophysical logging of 2,107.00 m in four boreholes and a cumulative drilling of 3,714.50 m in six boreholes. The subsurface data acquired from the boreholes indicated occurrence of coal-bearing Barakar Formation of appreciable thickness. Four coal zones (Zone-A to D in ascending order)were intersected between 97.70 m and 694.70 m depths within Barakar Formation. The thickness of individual seam zones ranged from 11.05 m (Zone-A) to 136.70 m (Zone-B). The thickest coal seam section of 11.80 m was intersected at a roof depth of 638.60 m in borehole BRRBLN-4. The cumulative coal thickness in individual boreholes varied from 40.60 m to 84.20 m.

During G2 level general exploration for Gondwana coal under the cover of younger formation in Hatmarwa block, northern extension of Hura Coalfield, Rajmahal group of coalfields, Bhagalpur district in Bihar, an area of 4.5 sq km was mapped on 1:10,000 scale and a total of 1,331.0 m of drilling in four boreholes were completed. The sub-surface data of boreholes indicated occurrence of coal-bearing Barakar Formation of appreciable thickness under the cover of younger Rajmahal Formation and Alluvium. Four coal zones (Zone-A to D in ascending order) were intersected between 256.00 m and 875.95 m depths within Barakar Formation. The thickness of individual seam zones was found to range from 41.40 m (Zone-A) to 132.10 m (Zone-B). Thickest coal seam section of 16.00 m was intersected at a roof depth of 733.25 m in Borehole BRRBH-4. The cumulative coal thickness in individual boreholes varied from 82.25 m to 105.90 m.

In Maharashtra, a G4 stage exploration for coal in Purad block, Wardha valley Coalfields, Yavatmal district comprised large-scale mapping on 1:10,000 scale and 457 m drilling in one borehole. Sub-surface study of borehole revealed that the area is devoid of coal of economic value. Nevertheless, at places thin vitrinite lamellae along with few coal streaks and stringers were noticed. Proximate data revealed that one local thin coal band recorded in Motur Formation with thickness 0.90 m was intersected within depth range of 154.83 m. and 155.73 m.

In Chhattisgarh, a G2 level regional exploration for coal in Kida block, Mand-Raigarh Coalfield, Raigarh district involved Large-Scale Mapping of 3.00 sq km area on 1:10,000 scale and a cumulative drilling of 3,815.20 m in five boreholes.The studied area is mainly represented by Barren Measures while scanty outcrop of Kamthi Formation was observed at the southern part of the block. Barakar Formation is the main storehouse of economic coal. Twelve regional Barakar coal seams/ zones (Seam I to X, XII and XIII in ascending order) were intersected between the depths of 168.20 to 917.75 m. Thickness of individual coal seam / zone varied from 0.50 to 19.45 m. Seam IV & I are the thickest seam which persistently intersected in all the boreholes. Seam-IV was developed in multiple splits whereas Seam-I was developed in single split. Grade of coal seams varied from G-6 to G-17. Geophysical logging of 1,647.53 m was completed.

During G2 level exploration for coal in Jobro east block, Mand-Raigarh Coalfield, Raigarh district, large-scale mapping of 5.00 sq km area on 1:10,000 scale and a total of 2,266.35 m drilling in four boreholes were carried out. Seven regional Barakar coal seams / zones (Seam X to III) were intersected between 328.55 m and 633.70 m depth. Thickness of individual coal seam /zone vary from 0.65 to 25.80 m. Seam VII+VI were found to be the thickest with cumulative thickness as 25.80 m. Borehole-wise, cumulative coal thickness of all the seams was seen to vary from 33.80 and 41.38 m. A total of 1,668.95 m geophysical logging were carried out in this block. Coal seams were observed as inter-banded in nature.

A G2 level general exploration involving large scale mapping on 1:10,000 scale over an area of 3.5 sq km and drilling of 3 boreholes to a cumulative depth of 4,029.0 m was carried out for coal in Karmagarh block, Mand-Raigarh Coalfield, Raigarh district, Chhattisgarh. Eight regional Barakar coal seams/zones viz; (X, IX, VIII, VII, VI, V, IV & III in descending order) were intersected between 494.50 m and 831.85 m depth. Thickness of individual coal seam/zone ranged from 0.50 to 21.20 m.

In Jampali block, Raigarh district a G2 level general exploration involved large-scale mapping of 3 sq km on 1:10,000 scale and 1,583.45 m drilling in 2 boreholes was carried in search of coal in the area. Twelve regional Barakar coal seams / zones (Seam I to X, XII & XIII in ascending order) have the continuity of already explored blocks. Seven regional Barakar coal seams zones (Seam IV, V, VI, VII, VIII, IX and X in ascending order) were intersected between 252.45 m and 686.62 m depth. Cumulative coal thickness of individual coal seam / zone was found to vary from 0.80 m to 23.29 m, whereas borehole-wise, cumulative coal thickness of all the seams varied from 5.32 m and 40.26 m. The thickest Seam IV continually intersected in both the boreholes.

In Madhya Pradesh, during G3 level preliminary exploration for Coal in Jhara block, Singrauli Coalfield, Singrauli district, an area of 13 sq km was mapped on 1:10,000 scale and a cumulative drilling of 2,975.80 m was completed in four boreholes. During drilling Raniganj coal seams were intersected between 38.25 m and 264.49 m depths. Four Raniganj coal seams (R-I to R-IV in ascending order) of regional extent were identified from the area. The thickness of coal seams varied from less than a meter to 4.35 m. Seam R-IV and R-III were persistently developed in the area. Besides regional seam, 3 local coal seams (R-L1 to R-L3) were also reported. Six Barakar coal seams (Seam-I to IV & VI to VII in ascending order) of regional extent were identified in Jhara block. All coal seams were intersected between 362.01 m and 829.47m depth. The cumulative thickness of the individual coal seams varied from less than a meter (Seam-VI) to 3.67 m (Seam-III). Among all these coal seams, Seam-III is the most important in terms of thickness and regional persistency. The extension of both regional Raniganj and Barakar coal seams was established for 5.5 km in dip direction and about 4 km along strike direction.

A G3 level regional exploration for coal was carried out in Kahua-Khireti sector, Pench Valley Coalfield, Chhindwara district, Madhya Pradesh. Large-Scale Mapping of 23.0 sq. km area was completed. Five regional Barakar coal seams were intersected (Seam no I to V) within a depth range of 356 m and 535 m. Depth range of coal seams was found to vary from 355.95 to 589.25 m. Thickness of individual coal seams varies from 1.40 to 6.20 m. Seam no. III is the thickest seam range from 4.57 to 6.20 m. Maximum cumulative coal thickness of 19.40 m was encountered in Borehole PKK-4. Borehole-wise cumulative coal thickness varied from 14.14 to 19.40 m.

During G3 level preliminary exploration for coal in Sagoniya sector, Pench Valley Coalfield, Chhindwara district, Large-Scale Geological Mapping of 14.0 sq km area on 1:10,000 scale, 1,564 m drilling in 4 boreholes and 1,041.98 m geophysical logging were carried out in the study area. Barakar Formation is the primary repository of economic coal in this basin, which is represented by fine to coarse-grained, occasionally friable, multistoried feldspathic sandstone interbanded with gray shale, carbonaceous shale and coal seams/zones. Basaltic flows of the Deccan Trap occupy all over the area and were intersected in all the boreholes. Five regional Barakar coal seams (Seam-I, II, III, IV and V in descending order) and a few local seams with thickness ranging from 0.60 m to 7.72 m, 12.23 m (cumulative) were intersected between the depths of 307.80 m and 332.30 m. In Borehole PSG-03, four regional coal seams (Seam-I, III, IV, V in descending order) were encountered.

A G2 level general exploration for Gondwana coal in Aturia block in the trap covered area of Birbhum-Brahmani Basin, Rajmahal group of Coalfields, Birbhum and Dumka districts of West Bengal & Jharkhand involved mapping of 5.0 sq km area in 1:10000 scale and a cumulative drilling of 2,496.40 m in six boreholes. The sub-surface data from the boreholes revealed occurrence of coal-bearing Barakar Formation of appreciable thickness under the cover of younger Dubrajpur Formation, Rajmahal Formation and Alluvium in ascending order. Cumulative coal thickness of 303.20 m was encountered in five boreholes at a depth range of 96.75 m to 451.60 m. The thickest coal seam section of 23.15 m was encountered at a roof depth of 276.85 m. Four regionally co-relatable coal seam zones (I to IV) in ascending order were established. The thickness of individual coal seam zone varied from 4.50 m (Zone-I) to 53.45 m (Zone-II).

In Nagaland, a G4 stage reconnaissance survey for coal was taken up around Baghty, Sanis, Chudi and Lotsu area of Wokha district. In the study area, coal was found to occur as streaks, lenses and pockets in Jenam, Renji and Girujan clay formations; workable coal seams were observed mostly in Jenam Formation. On the basis of large-scale mapping, a coal seam was established within Jenam formation with lateral thickening, thinning and pinching at places. The strike continuity of the coal seam is not continuous. The excavation/exploration of coals by the locals has exposed several coal seams in the area. The coal seam located to the west of Yonchucho and Longtsung seems to be the most promising in the study area with strike length of about 40 m and a thickness of about 1.9 m.The coal observed from the Jenam formation in the area are bright, black to brownish in colour, hard in nature with sub-vitreous to vitreous luster. Qualitatively, the coal in the study area have moderate to high moisture and ash content ranging from 2.67 to 14.23% and 4.43 to 74.81%, respectively with Gross Calorific Value range in from 1,065 to 6,190 kcal/kg and coal is of non-coking grade with grade ranging from ‘G’ to ‘B’. The Tertiary coal of the study area has high sulphur content with an average of 4.33%.

In Odisha, a G2 level general exploration for coal was carried out in Khandanal block, Talcher Coalfield, Angul district. During study, a total cumulative drilling of 3,632.60 m in eight boreholes were completed and 7.50 sq km coal field map was updated in 1: 10,000 scale.The entire coal seam zones in Khandanal block is confined within Barakar Formation and no coal seam zones were encountered in Karharbari Formation. Seven regional coal seam zones (Seam zone II, III, VI, VIII, IX, X and XI from bottom to top) were intersected within the depth ranges from 100.60 to 609.18 m from the surface in which Seam zone III occur in three split section. Seam zones IX and III (top, middle and bottom) are the most important in Barakar Formation for their thickness and regional persistency. In general,

borehole-wise cumulative coal thickness of all coal seams intersected in a borehole varied from 11.41 m in southern part to 58.29 m in northern part.

In Sundargarh district, a G2 level general exploration for coal was carried out in Kuanrkella block, Ib River Coal field. Four boreholes were drilled to a cumulative depth of 2,992.45 m in Kuanrkella block and a total of 471.22 m coal was intersected during this period. Two regional coal seam zones within Raniganj Formation (R-II & R-I in ascending order) and four regional coal seam zones within Barakar Formation (Ib, Rampur, Lajkura and Parkhani in ascending order) were intersected in this block within the depth ranging from 11.78 m to 774.00 m. Amongst these seam zones, R-I and Rampur are the most important coal seam zones of Raniganj and Barakar Formations, respectively for their thickness and regional persistency.

During G2 level general exploration for coal in Bagbarhi block, Ib-River Coalfield, Sundargarh district, 6 boreholes were drilled to a cumulative depth of 3,837.15 m in Bagbarhi block and a total of 458.60 m coal were intersected during this period.Two regional coal seam zones within Raniganj Formation (R-II & R-I in ascending order) and four regional coal seam zones within Barakar Formation (Ib, Rampur, Lajkura and Parkhani in ascending order) were intersected in this block within the depth ranging from 13.34 m to 750.28 m. Amongst these seam zones, R-I and Lajkura are the most important coal seam zones of Raniganj and Barakar Formations, respectively for their thickness and regional persistency. Cumulative coal thickness of R-I encountered in boreholes was seen to vary from 2.00 m to 4.91 m. Cumulative coal thickness of Parkhani, Lajkura, Rampur and Ib seam zone vary from 3.01 m to 8.62, 16.28 m to 28.10 m, 31.35 m to 60.63 m and 2.94 m to 5.33 m, respectively.

A G2 level general exploration for coal was carried out in Badibahal block, Ib-River Coalfield, Sundargarh district. Three boreholes were drilled to a total depth of 2,384.00 m in Badibahal Block and a total of 411.65 m coal were intersected during this period. Three regional coal seam zones within Raniganj Formation (R-III, R-II & R-I in ascending order) and four regional coal seam zones within Barakar Formation (Ib, Rampur, Lajkura and Parkhani in ascending order) were intersected in this block within the depth ranging from 13.85 m to 788.02 m. Amongst these seam zones, R-III and Rampur are the most important coal seam zones of Raniganj and Barakar formations, respectively for their thickness and regional persistency. Cumulative coal thickness of R-III, R-II and R-I intersected in boreholes varie from 4.98 m to 11.10 m, 0.91 m to 4.46 m and 4.87 m to 5.37 m, respectively. Cumulative coal thickness of Parkhani, Lajkura, Rampur and Ib seam zone was seen to vary from 9.21m to 10.43 m, 23.49 m to 33.63 m, 57.27 m to 65.34 m and 16.70 m to 20.38 m, respectively.

In Telangana, a G2 level general exploration for coal in Durgam Gutta block in south-eastern part of Godavari valley coalfield, Bhadradri-Kothagudem district involved large-scale mapping of 5.5 sq km area on 1:10,000 scale. Two boreholes TBKD-1 and TBKD-5 were drilled upto depths of 263 m and 291 m, respectively. Seam1 was encountered at a depth of 80 m in Borehole TBKD-1 whereas in Borehole TBKD-5, Seam-C of Barakar Formation was encountered at a depth of 25 m.

During G2 level general exploration for coal in Durgam Gutta north block in south-eastern part of Godavari valley coalfield, Bhadradri-Kothagudem district, large-scale mapping of 6.5 sq km area on 1:10,000 scale was carried out. The mapped area consists of Barren Measures and Lower Kamthi Formations of Lower Gondwana sediments. Barren Measures mainly found to be represented by siltstone, shale with minor amount of sandstone while the Lower Kamthi formation is made up of yellowish to greyish white, medium to coarse-grained sandstone.

Directorate of Mineral Resources, Meghalaya

Regional exploration for the feasibility study of coal block at Khliehriat, East Jaintia Hills was carried out in collaboration with CMPDI. An area of 1 sq. km was covered on large-scale mapping. A borehole was drilled to a depth of 30.5 m and 20 samples were collected. The top seams in the area were mostly encountered at a depth ranging from 3-3.5 m to 10 m with an average thickness ranging from 0.2 m to 0.7 m and mostly associated with cabonaceous shale. The second seam was encountered at a depth of around 7.3 m to 16 m and the average thickness was found ranging from 0.2 m to 0.5 m.

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 2,459.60 m drilling in 5 boreholes and sampling of 380.99 m core were carried out during the year 2019-20. Reserves/Resource estimation is under progress.

The Singareni Collieries Company Ltd (SCCL)

During 2019-20 (Apr-Dec, 2019), a total of 0.6088 lakh metres of drilling have been carried out in 15 blocks and also in the identified projects/mines by deplying 25 drills in the SCCL command area of Godavari Valley Coal Field.

A total of 46,693 m involving 173 boreholes were Geo-physically logged.

During the period, 8 boreholes core data were sent for Physico Mechanical Properties tests and results of 11 boreholes have been received. In various mines, 76 underground and 37 opencast visits have been carried out for geo-technical mapping and subsequently 20 geotechnical reports, 15 RMR reports and 9 'Q' value reports were submitted. A total of 46 Standard Penetration Tests (SPT) have been conducted for obtaining soil characteristics of proposed OB dump areas pertaining to various mines.

During the same period, in mining areas 145 piezometric wells and 339 Phreatic wells were monitored in all seasons. About 94 bore well sites were identified to augment water supply. One mine water inflow assessment investigation was carried out. Close to 13 Hydrogeological environment reports for EIA/EMP were submitted and 2 environmental inventory reports to submitted too were submitted to incorporate in GR.

Exploration activities in Penagadapa Captive Coal Block, GVCF in Telangana State have been completed by drilling 11 boreholes with a meterage of 4,682 m and Geological Report has been prepared and submitted.

As on 1.4.2019, the total measured coal resources in GVCF, Telangana amount to 10,622.32 MT (331) and the indicated and inferred geological resources amount to 8,564.74 MT (332) and 2,651.88 MT (333) respectively. The total geological resources of coal in GVCF, Telangana state are 21,838.94 MT (as per the National Inventory of coal for the year 2018-19).

CMPDI

During 2019-20, 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 2019-20, 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.

Table - 4: Exploratory Drilling by CMPDI (Departmental and Outsourcing) in 2019-20

Sl. No.	Agency	Target (lakh m)	Exploratory drilling achieved (lakh m)	Achieved (%)
1.	Departmental	5.05	4.885	97
2.	Outsourcing			
	i) State Govts.	0.01	0.027	272
	ii) MECL (MoU)	4.00	4.936	123
	iii) Tendering (CIL/Non-CIL Blocks)	4.94	3.088	63
Total		**14.00**	**12.937**	**92**

In 2019-20, CMPDI and its contractual agencies took up exploratory drilling in 132 blocks/mines spread over 22 coalfields in nine States. Out of 132 blocks/mines, 62 were Non-CIL/ Consultancy blocks and 70 CIL blocks/mines. Departmental drills of CMPDI were employed for exploratory drilling in 69 blocks/mines, whereas, contractual agencies undertook drilling in 63 blocks/mines. CMPDI extended its technical supervision in promotional/NMET exploration work undertaken by MECL in Coal Sector (CIL areas) in seven blocks. On behalf of Ministry of Coal, DGM, Nagaland, has also carried out promotional exploration in one block and CMPDI in three coal blocks and a total of 1.16 lakh metres of promotional (regional) drilling was undertaken for coal and lignite during 2019-20 through, CMPDI.

A total of about 12.94 lakh m of exploratory drilling have been carried out by CMPDI in 2019-20 of which deployment of departmental resources accounted for 4.89 lakh m while outsourcing involved 8.05 lakh m mainly from State Governments/MECL/Tendering (CIL/Non-CIL blocks). Details of exploratory drilling carried out by CMPDI in 2019-20 are given in Table - 4.

Lignite

GSI

The details of investigation for lignite during 2019-20 by GSI is elicited below:

In Tamil Nadu, during a G3 level preliminary exploration for lignite in Chittarkottai sector, Ramnad sub-basin, Ramanathapuram district, five boreholes were drilled and a total of 65 samples of limestone were collected from the study area. The analytical results in the core sample from these boreholes showed that all the lignite is of Category "B". Lignite in Borehole TRCK-03, TRCK-04, TRCK-05, TRCK-06 and TRCK-17 was intersected from 423 to 426 m (3 m thickness), 425.6 to 424.6 m (9.6 m thickness), 443 to 450 m (7 m thickness), 412.5 to 420 m (7.50 m thickness) and 403 to 408.50 m (5.50 m thickness), respectively.

Neyveli Lignite Company India Ltd

a) Promotional Regional Exploration

During the year 2019-20, a target of 35,000 metres of drilling work under Promotional exploration was allotted in the States of Tamil Nadu and Rajasthan. Out of which, 30,000 meters have been allotted to MECL while 5,000 meters have been allotted to NLCIL which through MoU would be undertaken by MECL.

b) Detailed exploration by NLCIL under MoC Central Sector Scheme

During the year 2019-20, MoC has allotted 30,000 m in RS. Mangalam block, Ramnad, Tamil Nadu to NLCIL under Central Sector Scheme of MoC. NLCIL subsequently entered into on MoU with MECL during November-2019 for taking up this detailed exploration work.

c) Detailed Exploration under NMET Scheme (MoM)

During the year 2019-20, a target of 25,000 m of drilling work were earmarketed for MECL to be carried out in the State of Tamil Nadu.

d) Contractual scheme By NILCIL

During 2019-20 (up to November 2019), NLCIL has not taken up detailed/check drilling work in any of its future lignite blocks.

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 2019-20.

GSI

The details of exploration activities carried out for base metal by GSI during 2019-20 are furnished in Table-5.

MECL

In Karnataka, a G 4 level exploration for copper lead, zinc, cobalt and nickel was taken up in Ranebennur block, Haveri and Davanagere districts with exploration work that involved geological mapping of 463 sq. km area on 1:12,500 scale, 440 m drilling in 5 boreholes and analysis of 1,771 samples including 671 stream sediments samples and 52 samples for petrography/mineragraphy/etc. Reserves/ Resources have not been estimated.

In Rajasthan, exploration for base metals, associated elements, gold and REE in Kachola-Amargarh-Jhikri areas in Bhilwara district was taken up with an objective to (i) demarcate the rock types favourable of hoisting base metals, gold, REE and associated elements in the areas, (ii) collect samples to analyse them for Cu, Pb-Zn, Ni, Co, Au, Ag & REE and (iii) estimate resources. Geological mapping of 88.00 sq.km was carried on 1:12,500 scale. Surface sampling and geophysical survey established mineralisation zone around shear zones. During field investigation, one borehole was drilled to a depth of 140 m and a total of 528 samples of different types were collected and analysed.

In Udaipur district, a G4 level exploration for copper and gold was taken up in Vasu-Jagat-Kharwach & Saran-Bharwawat block. Exploration work comprised geological mapping of 124 sq. km area on 1:12,500 scale and collection of 513 samples including 147 pit/trench/channel samples. Besides, magnetic survey, self potential, resistivity and induced potential surveys were also carried out in the area. Reserves/Resources have not been estimated.

In another area of Deravad-Chargarhia-Bansra, Udaipur district, a G4 level exploration for copper and gold was taken up with the broad objectives to (i) carry out geological mapping and demarcate the rock types of copper and gold-bearing formation and lateral disposition of ore body, (ii) collect and analyse samples, (iii) estimate resources, etc. Exploration work involved geological mapping of 108 sq.km area on 1:12,500 scale and collection of 457 samples including 16 channel samples. A total of 9 boreholes were drilled to a cumulative depth of 675 m. Resources have not been estimated.

In Odisha, a G4 level exploration for copper was taken up in South of Kesharpur block, Mayurbhanj district with exploration work that comprised geological mapping of 110.40 sq. km area on 1:12,500 scale, 663 m drilling in 3 boreholes and collection of 818 samples including 60 samples for XRD/ spectroscopic studies/petrography/etc. Reserves Resources have been estimated at about 1.96 million tonnes of ore with 0.28% Cu under UNFC code 334.

Hindustan Zinc Limited

During the year 2019-20, the ore reserves of HZL have been increased by 22 million tonnes to 11.47 million tonnes and HZL added 14.5 million tonnes of ore on a gross basis.

Table - 5: Exploration for Base Metals (Copper, Lead & Zinc) by GSI, 2019-20

State/District	Name of block	Details of exploration	Results
Arunachal Pradesh			
Papum Pare	Dedollo block	Mapping, & Sampling	During preliminary (G3 stage) exploration, detailed mapping of 1.8 sq. km on 1:2000 scale was carried out. Mineralisation occurs in quartz mica phyllite, quartz mica schist, biotite schist and also in granitic gneiss. The mineralised zone is well exposed in the east of Dedollo along the road section for a strike length of 360 m. Two zones of 30 m and 12 m were noticed on the road section east of Village Dedollo. Malachite and azurite stain were observed in quartz mica phyllite, biotite schist and also in quartz. Analytical results of two boreholes samples showed Cu 3,056 ppm and 1,401 ppm, while other samples showed Cu < 1,000 ppm.
	Balapu-Niyamlo area	Sampling	Reconnaissance (G4 level) exploration was taken up with an objective to delineate copper and associated mineralisation. Sulphide mineralisation was identified in Kheel-Geram area for a strike length of about 2 km with width of about 500-600 m. Sulphide mineralisation in the form of pyrite, pyrrhotite, chalcopyrite and bornite in quartz-mica schist and augen gneiss was noticed in Tashi, Laptap and Chiputa areas. Analytical results of bedrock samples from the mafic unit showed vanadium values in the range from 593 to 904 ppm, Cr values from 427 to 715 ppm and Sn from 275 to 663 ppm in Geram area. Samples from augen gneiss near Laptap area showed 1,050 ppm of Cu. In Tashi area, samples from mafic band within augen gneiss showed 2,442 ppm of V, 438 ppm of Cr and 547 ppm of W. Sample from garnetiferous quartz-mica schist with quartz veins near Village Tashi showed 4,700 ppm of Cu.
	Khyate-Parang area	Mappning, Trenching & Sampling	Reconnaissance (G4 stage) survey in the area involved mapping of 50.0 sq km area on 1:12,500 scale, pitting/trenching and sampling. In south of Khyate area, two sulphide-bearing mineralised zones were delineated. Each zone was found to extend for about 20-50 m along the strike continuity and is discontinuous in nature. Sulphide mineralised zone, SZ-I strikes NE-SW over a width of about 30 m. One 3 m thick band of chlorite-amphibole schist on the southern end of the zone host the main mineralisation. SZ-II appears as lensoidal body with a width of 5 m. Mineralisation is hosted within the amphibole schist and quartz vein. The quartz vein is 1-1.5 m wide. In the SZ-I, copper values ranged from 10 ppm to 445 ppm in one trench and 30 ppm to 150 ppm in other trench. Analytical result from one channel yielded 35 to 275 ppm Cu. In SZ-II, one trench and channel each were made which analysed 25 to 175 ppm Cu from the trench samples and 2,500 to 11,000 ppm Cu, 170 to 1,300 ppm Zn from the channel sample. One BRS sample from the sulphide-rich quartz vein from this zone also yielded 15,000 ppm Cu. The amphibolite rocks sample yielded 16.04 % to 49.01% of Fe_2O_3.

(contd)

Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
Dibang Valley	Angolin-Etalin area	Mapping & Sampling	During Reconnaissance (G4 stage) survey, an area of 50 sq km was mapped on 1:12,500 scale. Direct surface manifestation of copper, molybdenum mineralisation was evidenced from the malachite staining and direct visual perception of molybdenite crystals in form of veins within the pegmatites, quartz veins. Chemical analyses of samples are awaited for the detailed geochemical study. The result of one sample showed copper value of 7,722 ppm.
	Isholin-Anelih-Endolin area	Mapping & Sampling	During Reconnaissance (G4 stage survey), an area of 50.0 sq. km was mapped on 1:12,500 scale. The chemical analysis of bedrock samples of graphitic marble showed presence of CaO ranging from 50.5 to 55.04 % and fixed carbon up to 27.62%. The chemical analysis of bedrock samples of hornblende schist shows presence of Cr, ranging up to 1,699 ppm. The samples from a channel cut across the carbonaceous phyllite, amphibole-bearing chlorite schist and graphitic marble has given Cr and Ni values of 2,864 ppm and 1,285 ppm, respectively. The Au concentration in the area ranges from 100-180 ppb. Also, one PCS sample has yielded Cu value of 12,985 ppm. The chemical analysis of stream sediment samples showed presence of Au ranging from 50-220 ppb. The chemical analysis of trench samples showed presence of Cr, Zn and Cu values 1,317-2,027 ppm, 900 ppm and 740 ppm, respectively with an anomalous value of 11,439 ppm for Cu in bed-rock samples.
Maharashtra			
Chandrapur	Lal Heti North block	Mapping, Geophysical survey, Pitting/ Trenching & Drilling	G3 level preliminary exploration comprised detailed mapping of 1.0 sq km area on 1:2000 scale, geophysical survey of 6 L.km, 50.0 cu. m pitting/ trenching and 600.0 m drilling. During integrated geophysical survey, a high chargeability zone was established which corroborated with analytical results of soil samples. It was also observed that sulphide mineralisation in Lal Heti north block is mainly associated with the chlorite alteration zones and quartz carbonate veins in the form of dissemination, stringers and veins along the fractures. The primary copper ore at Lal Heti north block is chalcopyrite. With a cut-off grade of 0.2% and minimum stopping width of 1.5 m, three mineralised lodes were demarcated in MHCL-1 and one mineralised lode was demarcated in MHCL-2. Preliminary resource of 1,34,278.2 tonnes (0.13 million tonnes) over 500 m strike length with an average grade 0.31 % Cu has been indicated.
Gadchiroli	Navgram block	Mapping, Geophysical survey & Drilling	G3 level exploration work in the area includes detailed mapping of 1.0 sq.km area on 1: 2000 scale, drilling of 3 boreholes to a total depth of 390.80 m and geophysical surveying along with trenching, sampling, etc. Chemical results of the

(contd)

Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
			two boreholes core samples yielded no significant encouraging values. Third borehole was drilled to a depth of 125.50 m and the target reef was intersected as bifurcated limbs with widths of 4.7 m (82.6 to 87.3 m) and 7.3 m (114.3 to 107 m).
Gondia	In and around Nawegaon, Dasgaon Area	Mapping & Sampling	During G4 level study, an area of 100.0 sq.km was mapped on 1:12,500 scale and two parallel mineralised quartz veins 60 m apart were found in Ratnara area (northern vein is >500 m X 10 m and southern vein >500 m X 20 m). The mineralisation is confined in quartz vein intruded into basement gneiss and quartzite. Strong evidence of secondary Cu enrichment is found in the area. Base metal sulphide (Cu-Pb) bearing favorable zone identified in (i) Wirsi (Cu-Pb-Fe)-Chalcopyrite, Galena, Pyrite and Covellite; (ii) Pagatola (Cu)-Chalcopyrite and Chalcocite and Ratnara (Cu-Fe-Pb-Zn)-Chalcopyrite, Pyrite, Galena, Bornite, Covellite, Chalcocite, native copper, Sphalerite and Pyrrhotite. Chemical analytical results of 86 bedrock samples showed copper values in the range from 10 ppm to 870 ppm, Pb from 10 to 120 ppm, Zn from 10 to 440 ppm, Cr 50 to 1,400 ppm, Ag from 1 to 3 ppm and Au values below 50 ppb. Chemical results of 20 nos. trench samples showed Cu value ranging from 20 to 270 ppm, Pb from 10 to 80 ppm, Zn from 10 to 150 ppm, Cr 50 to 1,700 ppm and Ag from 1 to 2 ppm while 01 nos. trench sample (T1-A) yielded tungsten value of 449.31 ppm.
	Chikli-Dongargaon area	Mapping & Sampling	G4 level exploration was taken up along western boundary of Dongargarh fold belt. Evidences of sulphide mineralisation like limonitisation, hydrothermal brecciation and abundant presence of boxwork structures were observed in the area. In this vein, sulphide minerals occur in two modes of mineralisation – randomly disseminated chalcopyrite-pyrite grains and fracture filling chalcopyrites. In older vein, average concentration of Cu observed is 120 ppm and that of Pb and Zn it is 106 and 54 ppm, respectively. Highest Cu and Pb values are obtained from a single outcrop near Kaulewada. In younger veins, average concentration of Cu found is 840 ppm and that of Pb and Zn it is 40 and 70 ppm, respectively. Higher Cu values were noticed from confluence zones of the older vein and the younger veins near Kolargaon and Kusumghat. Evidence of extensive oxidation and leaching in the older vein indicates probable presence of base metal sulphide deposit underneath.
Bhandara	Dewahra & Setepar		G4 stage exploration was taken up in Dewahra and Setepar area. Majority of the samples analysed showed Cu 20 to 90 ppm, Pb 10 to 30 ppm and Zn 20 to 90 ppm with indications very low incidence of base metal mineralisation. Only one sample in Dewarha quartz vein showed Pb value of 820 ppm

(contd)

Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
			and 0.22% Zn. The total REE values in Dewara quartz vein have been analysed to be 9.3 ppm to 431.78 ppm. Results of few a samples from Palora quartz vein indicated absence of any base metal mineralisation. The total REE values in the Palora quartz vein indicate very low values of REE. The quartz veins exposed in Nagjhira Reserved Forest area showed total REE values ranging from 17.78 ppm to 285 ppm. Results of few a samples from Khadki indicated absence of any base metal mineralisation. Results of a few samples for total REE showed a range from 100 ppm to 120 ppm.
Chhattisgarh			
Surguja	Oranga-Dhulangi area		Reconnaissance G4 Stage, exploration was taken up in the study area. The calc-silicate rock and associated amphibolites host galena, sphalerite and chalcopyrite-mineralisation in the form of disseminations, stringers and cavity fillings. The galena-sphalerite-chalcopyrite association was better observed in the calc-silicate rocks. Besides base metal, graphite mineralisation occurring as surface exposure within Indravatipur forest and its sub-surface extension was noticed within the old pits and quarries at different locations of Village Indravatipur.
Surguja and Balrampur	Bhelai-Kudartola-Dhorpur area		Reconnaissance G4 Stage, exploration was taken up in the Bhelai- Kudartola- Dhorpur area. A well-developed gossan zone having 10 m width and 15-20 m in length was observed along the Gagar Nadi section near SW of Village Dumki. Surface of this gossan zone outcrop is light brown to brownish red due to the leaching of sulphide specks. Across the field area, sulphide mineralisation in the form of disseminated pyrite specks are seen commonly present in calc-silicate and dolomitic limestone.
Madhya Pradesh			
Dewas	Tamkhan and Bagda-Sawasri	Sampling	G4 Stage exploration was taken up in the area. The study showed new potential zone of base metal mineralisation near Village Saktia. The host rock of base metal is grey smoky quartz vein extending for approximately 600 m in length in NW-SE direction. The surface manifestation for copper mineralisation is observed over a strike length of 140 m having 2-3 m thickness in the form of stains of malachite along the fracture planes, fibrous malachite and variegated alteration along with fresh sulphides. The chemical analysis of bedrock and channel samples from Saktia area yielded good results showing Cu value up to 8,885 ppm, Pb value up to 2,430 ppm, Zn up to 385 ppm, Ag 30 ppm and Au 70-80 ppb. E-W trending Quartz vein near Biloda and Chichli showed pyrite, chalcopyrite and galena association in dissemination form and BRS sample showed Cu values upto 1,600 ppm along with Pb upto 5,430 ppm and one samples yielded gold value of 630 ppb. NN-SE trending quartz vein near Bagda shows galeng mineralisation in

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Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
			dissemination form yielded Cu-395 ppm, Pb-575 ppm, Zn-2620 ppm and Au-360 ppb.
Hoshangabad	Ratatalai- Mangrul-Bhadugaon-Jhugariya area	-	During G4 stage exploration, 50 cu. m of trenching/ pitting was carried out in the area. Surface mineralisation of copper occurs in the form of malachite staining in quartzite to the north of Village Dewas. Fe encrustation, chalcopyrite and pyrite were observed in and around Teli Ki Sarai, Bhadugaon and Hirapur villages mainly in ferruginous quartzite. Near Village Mangrul dissiminated sulphides were seen in calcite vein. Sample collected from the quartzite showed Cu values ranging from 10 to 950 ppm and Zn from 10 to 240 ppm. Sample with malachite stains taken from quartzite near Village Bhadugaon showed Cu values as 1,950 ppm. Another sample showed Zn value of 690 ppm within quartzite with scattered sulphides near Village Hirapur. Pb values were seen ranging from <10 to 60 ppm.
Gwalior	Around Lakhnauti, Bilaua and Antri areas	Mapping & Sampling	During G4 stage exploration, an area of 100.0 sq km was mapped on large scale. The study area was divided into two blocks–Lakhnauti block and Bilaua block. Bedrock samples (BRS) from quartz reef near Lakhnauti showed encouraging Cu values varying from 60 to 6,500 ppm with overall average of 1,550 ppm, Pb value from <10 to 210 ppm, Zn < 10 ppm and Ag < 1 ppm. The chemical analysis of channel samples indicated presence of Cu values from 15 to 6,700 ppm and helped to delineate a 250 to 300 m long zone with average 2 m width and average Cu values of 0.1%. The pit samples indicated Cu value from <10 to 5,400 ppm in the area. The initial BRS samples from the quartz reef near Bhaggeh and Ainti have shown Cu value <10 to 120 ppm, Pb value was seen ranging from <10 to 335 ppm, Zn value from <10 to 575 ppm, Cd value < 10 ppm and Ag values < 1 ppm. BRS samples collected from the quartz reef around Chirpura, Udalpara and Rafatpura villages showed Cu value from <10 to 1,800 ppm, Pb value from 15 to 515 ppm, Zn value from <10 to 95 ppm, Cd value < 10 ppm and Ag value < 10 ppm.
Betul	Dehalwara block	-	G2 stage exploration was carried out in the area. Occurrences of sphalerite, galena, chalcopyrite, pyrite and pyrrhotite in the form of disseminations, sub-massive thin bands, stringers, specks, etc along foliation plane, fracture and joint planes are the main repository sites of sulphide mineralisation in the study area. The base metal mineralisation in the study area is disseminated one and the grade of the ore body is the function of the segregation of specks. Although the massive sulphide bands parallel to the foliation are common, however, their distant separation dilutes the grade. During G4 stage exploration, two potential rocks have been identified for base metal mineralisation.

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Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
	Bhandawari-Bhurkal-Chhipaniya-Bodur area	Sampling	The potential rock was tuffaceous quartz-mica schist with association of small size bands of metarhyollite exposed around Jamdehi Kalan area and garnetiferous quartz mica schist exposed around Surnadehi area. Systemetic soil sampling in Jamdeh Kalan and Surnadehi areas were carried out with an objective to delineate possible anomalies. Bedrock samples result showed highest Zn value up to 385 ppm and Cu up to 510 ppm from hornblendite. Highest Pb value was 350 ppm observed from quartzite. Trench sample showed highest Zn values of 165 ppm, Pb 65 ppm and Cu > 30 ppm. Result of soil samples showed highest Zn values of 180 ppm, Pb 185 ppm and Cu > 60 ppm.
	Muariya block	Drilling	General G2 stage exploration was taken up in the Muariya block. A total of 7 boreholes were drilled to a cumulative depth of 1,470.00 m. In the eastern most part of the block, Borehole-2 had intersected an ore zone (2.90 m, 1.64% Zn), Borehole- 06 had intersected 4.8 m width & 0.8% Zn and Borehole-03 & borehole-04 had not encountered any significant ore zones at 60 m vertical depth. In the western part of the block, Borehole-01 intersected four ore zones (Ore zone-I: 2.4 m, 1.95% Zn, Ore zone-II: 2.99 m, 1.03% Zn, Ore zone-III: 2.22 m, 1.12% Zn & Ore zone-IV: 2.16 m, 1.18% Zn).
	Banskhapa-Pipariya sub block-I	Drilling	Preliminary (G3) stage investigation was taken up to assess the strike extension of base metal mineralisation in northern part of Banskhapa-Pipariya sub-block-I based on the geochemical anomalies for Zn & Cu and mineralisation intersected in previous field season. A total of 4 boreholes were drilled to a cumulative depth of 515 m. Based on the analytical results of the core samples, none of the boreholes intersected the mineralisation even up to the lower limit of cut-off values (1% for Zn & 0.2% for Cu). The project was closed prematurely due to the absence of expected mineralisation as a result of drilling.
Chhindwara	Borkhap block	Mapping, Pitting/ Trenching & Drilling	G3 stage exploration in the area comprised mapping of 0.50 sq.km areas on 1:2,000 scale, pitting/ trenching of 50.0 cu. m and drilling of 6 boreholes to a total depth of 621.55 m. The study revealed that the gahnite is the only indicator mineral of Zn mineralisation in the area. Boreholes were drilled to check the depth persistence of mineralisation at 50 m vertical depth. A total of 04 soil geochemical anomalies for Zn and 02 geophysical chargeability anomalies were demarcated in the Borkhap block. The detailed core logging revealed that the mineralisation in Borkhap area occurs in the form of small disseminated specks and thin stingers of sphalerite and occasionally chalcopyrite along the foliations and fractures. The mineralisation is discrete and patchy in nature. The borehole data showed that the Zn values varied from 200 ppm to 1%. At 0.2% Zn cut off and 2 m stopping width, four feeble mineralised zones (contd)

Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
			having width of 4 m, 2 m, 5 m and 3 m with Zn value of 0.36%, 0.72%, 0.21% and 0.21% respectively can be inferred. In another borehole Zn values varied from 90 to 950 ppm, Pb from 230 to 530 ppm and other elements were found to be in traces.
	Gorakhpur-Toranwari-Bardhana area		G4 stage exploration was taken up in the area. Mineralisation in the area was observed to be associated with volcanic hosted massive sulphide type deposit. The alteration zone was marked within the host rocks (altered rhyolite) having potential mineralisation and subsequently four alteration zones have been identified. Malachite staining was observed in the altered rhyolite outcrop. Some oxidised surfaces containing pyrites in disseminated and stringent form were also observed. Sulphide mineralisation, such as, pyrite, bornite, covellite were observed in mafic rock (dug well rocks) south of Mohgaon (Kisan) village.
Tikamgarh and Chhatarpur	Baldevgarh-Kharagpur-Dhanera-Magri area	Mapping & sampling	During reconnaissance G4 stage investigation, an area of 918.00 sq km was covered under reconnaissance survey and 135.00 sq.km area was mapped on 1: 12,500 scale. Sulphide mineralisation in the form of pyrite, chalcopyrite, molybdenite and very few specks of bornite, covellite etc. were observed mainly at a depth of 10-15 metres, which was exposed at the rock quarry and well dump samples. As per XRD data of three samples, concentration of fluorite (2%) showed high in medium-grained biotite syenogranite and hydrothermal breccias in SW of Chobara.
Katni	Poniya, Pondi, Mohaniya and Baragaon areas		During reconnaissance G4 stage exploration, an area of 100.0 sq km was mapped on 1:12,500 scale. The study revealed the presence of chalcopyrite, bornite, chalcocite, pyrite, galena and magnetite minerals as the primary minerals. Stains of malachite and azurite forms the secondary mineralisation and provided surface indications for presence of copper mineralisation. Copper mineralisation is confined to fold closures and also limbs are favourable location for copper mineralisation. Discontinuous copper mineralised zone of strike length 600-700 m was observed north of Village Baragaon. This zone was found to have a cumulative thickness of about 4-5 m while individual band thickness was not more than that of 1 m. Copper value in this zone varie from 515 ppm to 0.11%.
	Hardua block, Bahoriband Tehsil	Mapping & sampling	During reconnaissance G4 stage exploration, an area of 100.00 sq km was mapped on 1:12,500 scale. In Hardua block, base metal mineralisation was observed within the quartz/ carbonate veins in the forms of specs, stringers and blebs of pyrite and chalcopyrite. The partial analytical results showed Cu value up to 330 ppm near Village Bhula. Near Hardua hill detached outcrop had indicated Cu values up to 265 ppm, Zn value up to 2,120 ppm.

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Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
			Near Village Ligri sheared phyllite intruded by quartz veins exposed for about 50 m strike length had given Zn value up to 1,475 ppm. The bedrock samples (BRS) from BIF showed Fe_2O_3 values ranging from 17.44% to 62.28% with an average Fe_2O_3 value of 44% indicating very low-grade iron ore.
West Bengal			
West Medinipur	Around Bhulabeda-Olodchua area	Mapping & Sampling	During reconnaissance (G4 stage) survey of area, a total of 100.0 sq. km area were mapped on 1:12,500 scale. The sulphide mineralisation observed in the area was mostly disseminations of chalcopyrite and pyrite. Besides sulphide, magnetite and haematite are also observed in talc-schist. The meta ultramafites at Gohalberia showed encouraging values for Ni (833 and 970 ppm) and Cr (2,266 and 2,378 ppm) and Cu (1,000 ppm). The BRS sample collected from quartz vein at Gohalberia reported 4,100 ppm Pb.
Odisha			
Deogarh	Dengamunda-Mednipura area	Mapping, Pitting/ Trenching & Sampling	During reconnaissance survey (G4 stage) exploration, a total of 100.00 sq. km area were mapped on 1:12,500 scale and 60 cu. m of pitting/ trenching were carried out. Three feruginised zones were delineated in the study area viz. Zone-I was exposed near Darjimunda area (425 m length and 180 m width); Zone-II was exposed in Badudihudi area (180 m length and 80 m width) and Zone-III in the Lakhabahal area (430 m length and 130 m width). The analytical results of bedrock samples showed copper values varying from 5 to 5,000 ppm, cobalt 13 to 4,000 ppm, Ni 12 to 2,000 ppm, Pb 5 to 116 ppm and Zn 9 to 1620 ppm. Out of 71 bedrock samples, six samples showed higher copper values from 680 to 5,000 ppm, cobalt 1,106 to 4,000 ppm and Ni 229 to 2,000 ppm. The analytical results of 10 pit and trench samples showed copper values varying from 270 to 2,220 ppm, Co 134 to 4,736 ppm, Ni 77 to 1,100 ppm and Zn 51 to 830 ppm. The analytical results of one petrochemical sample showed higher values of Cu 4,168 ppm, Co 1,999 ppm and Ni 2,401 ppm.
	Rampali block	Geophysical survey, Trenching & Sampling	During general (G2 stage) exploration, a total of 100 cu. m of trenching work were carried out and a total of 90 samples were generated in Rampalli Block. A total of 20 L km Magnetic, 19 L km SP and 19 L km IP Resistivity were completed in the area. The ground geophysics survey has identified two anomalous zones. After considering the previous analytical results, zones were recalculated at 0.2% Cu cut off. Considering 0.2% Cu cut off, two lodes have been established. The Lode-1 was established for a strike length of 200.0 m with width varying from 2.83 to 5.67 m. Similarly, the deeper series borehole intersected Lode-1 with a true thickness of 21.10 m with an average of 0.35%

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Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
			Cu at 0.2% Cu cut off. This signifies that the thickness of Lode-1 increased at deeper level. Lode-2 has been established for a strike length of 100.0 m.
Mayurbhanj	Dudhiasol east block	Mapping, Geophysical survey, Trenching & Drilling	During General (G2 stage) investigation, detailed geological mapping of 1.0 sq. km area on 1:2,000 scale, 100 cu. m of trenching, 15 L.km of ground geophysical survey and 2,599.85 m drilling in 12 boreholes were carried out. Exploration revealed that the sulphide minerals, i.e., pyrite, chalcopyrite and pyrrhohtite were found in association with minor nickel. The part chemical data showed maximum copper value as 2,770 ppm. The trench showed a 4.00 m x 0.20% Cu zone. Based on first level boreholes intersection in ore body, about 650 m strike length of the mineralised zone has been established in the block area. The cumulative thickness of copper lode varied from 2.30 to 34.40 m with average thickness of 11.00 m and with average grade 0.43% Cu at 0.20% Cu cut-off. Based on the 2nd level of intersection, the cumulative thickness of copper lode varied from 7.00 to 40.15 m with average thickness of 20.00 m and average grade as 0.35% Cu at 0.20% Cu cut-off.
	Madansahi block	-	General (G2 stage) exploration was taken up in this previously explored block. A total of 31 boreholes were drilled in the area so far. During FS 2019-20, 2nd and 3rd level explorations were done to establish the depth persistence of the mineralisation and a total of 14 boreholes were drilled. All the boreholes drilled have intersected copper mineralisation and the cumulative sulphide zone thickness was found varying from 17.00 to 52.00 m along the borehole. Based on the part chemical results of 10 boreholes, the average copper lode thickness was 15.00 m with 0.54% Cu at 0.20% Cu cut-off and the cumulative copper lode thickness varied from 3.00 to 34.00 m along the borehole.
Jharkhand & Bihar			
Giridih & Jamui	Bengabad & in Pratappur area	Mapping, Pitting/Trenching & Sampling	Reconnaissance (G4 stage) survey in the area comprised mapping of 100.00 sq km on 1:12,500 scale and 100 cu. m. of pitting and trenching. Surface indications of mineralisation were noticed in the form of malachite-azurite stains, bornite and disseminated sulphide grains within dolomitic marble. The malachite stains were noticed in talc-tremolite-actinolite schist and in mica schist. Talc-tremolite- actinolite schist was found to extend from SE to SW of Village Gansasar for a length of about 1,000-1,200 m with width ranging from 40-50 m. Dolomitic marble of various dimensions ranging from 100-120 m length & 10-20 m width and from 800-900 m length and width 30-40 m was traced around SW and SE of Gansasar, south of Purnadih and southeast of Bansjor villages. The chemical analysis result showed Cu values ranging from 1,045 to 24,000 ppm, Pb values ranging from

(contd)

Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
			1,046 to 4,835 ppm and Zn values ranging from 1,007 to 1,69,403 ppm. The maximum values of Cu, Pb and Zn were obtained from dolomitic marble. Overall, the results showed very less concentration of sulphide and carbonate hydroxide within the host rock. All the 35 samples showed anomalous value concentrated within a small block of 250 m × 50 m located to the west of Village Gansasar.
Manipur			
Tengnougpal	Around Kwatha-Namjet Lok area	Mapping & Sampling	Recconnaissance (G4 stage) survey involved Large-Scale Mapping of 50.0 sq. km area on 1:12,500 scale along with 50 cu. m of pitting/trenching. Analytical results of bed-rock sample showed higher concentration of Ni (1,476-5,819 ppm), Co (53-536 ppm) and Cr (1,264 ppm-1.16%). The chromite mineralised prospect block measuring 0.8 x 4 km area was delineated to the east of Village Kwatha, which expose four lodes of massive chromite. The massive steel black chromite showed encouraging values of Cr_2O_3 42.71-49.66%, Ni 940-1,180 ppm and Co 163-224 ppm. Two supergene Ni-Co lateritic mineralised blocks were demarcated as Chalwa and Sadangching block. The lateritic soil samples showed relative enrichment of Fe_2O_3 (8.24 to 48.34%), Al_2O_3 (1.25 to 18.3%). The encouraging values of Ni were seen within the lateritic soil (2,000-8,000 ppm). The high values of Ni correspond to the saprolite lateritic soil horizon. The other associated mineral commodities in the mapped area included rhodingite hosting precious/semi-precious stones (moonstone, blue sapphire and jadeite) and talcose magnesite.
Sikkim			
	South-east of Jugdum, Arubote area	Mapping, Geophysical survey & Sampling	Preliminary (G3 stage) exploration in the area covered detailed mapping of 1.1 sq.km area on 1:2,000 scale along with geophysical investigation of 10.52 L.km. Magnetic survey and 1 L.km SP survey. Sulphide mineralisation (pyrite) was observed within a quartz vein at a single location as veinlets and disseminations. The chemical analysis results showed the average amount of Cu in soil as about 55 ppm (32 nos.). The amount of Cu varied from 90 ppm to 600 ppm in BRS samples (48 nos.). Two samples of quartz veins within amphibolite body, having width of 30 cm each showed enormously high value of Cu, i.e., 0.15% and 0.23%. Only one channel sample of inter-banded phyllite-slate-quartzite having width of 50 cm showed erratically high value of Cu i.e. 4,350 ppm while rest of the channel samples showed marginal values varying from 10 ppm to 645 ppm (25 nos.).
East and South District	Mangkha-Mangalbare area	Sampling	During G4 stage survey in the area, the ultramafic bodies in the form of lenticular sills having thickness 5-10 m were observed in Mangle and Khamdong area. The bedrock samples indicated Cu, Zn and Pb values ranging from 1 ppm to 45 ppm, 22 ppm to 101 ppm and 7 ppm to 125 ppm,

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Table-5 (contd)

State/District	Name of block	Details of exploration	Results
			respectively. The mineralisation around the study area is hosted mainly in quartz veins and occasionally in phyllites. The sulphide materialisation in this area can be traced only from surface manifestations like malachite stains and specks.
Uttarakhand			
Pithoragarh	Ajera-Pasma area	Mapping & Sampling	Reconnaissance (G4 stage) study in the area include Large-Scale Mapping of 50.0 sq km area on 12,500 scale along with collection of 91 soil/ slope wash samples. In field, no potential zone of mineralisation was found but based on replacement of actinolite by biotite in petrological studies of mafic tuff, a 300 m long and 30 m wide alteration zone was inferred. The analysis of BRS samples did not give any encouraging values for potentiality of base metal mineralisation in the area.
Rudraprayag	Bamera-Gwar-Dhanpur area	Mapping	During reconnaissance G4 stage investigation, an area of 50 sq km was mapped on 1:12,500 scale. The sulphide mineralisation was noticed in Dobri area within dolomite. An area of about 1 sq km between Gwanagarh peak (east), Dhuya (west), Dhanpur (north) and Dobri (south) was identified as the most prospective area from the mineralisation point of view.
Haryana			
Mahendragarh \	North of Bakrija (Sareli area)	Sampling	Reconnaissance (G4 stage) project was taken up with an objective to establish the strike extension of copper mineralisation in north of Bakrija (Sareli area) in alluvial covered area using the available exploration and geophysical data. Ore microscopic studies showed presence of specks of disseminated chalcopyrite in amphibolite and banded amphibole marble-quartzite. Surface indication of copper mineralisation is seen only in Ghatesar area, where two ancient mining pits are observed within the micaceous quartzite host rock. The analytical results of chip samples collected from the four walls of the pit showed copper values ranging from 895 ppm to 3,408 ppm with mean value of 1,989 ppm. The results of BRS/trench/pit samples showed Cu values ranging from <10 to 671 ppm.
Jammu & Kashmir			
Baramulla	Darakanjan-Bela Salamabad-Uri area	Mapping	During reconnaissance G4 stage survey, Large-Scale Mapping of 101.0 sq km on 1:12,500 scale was carried out with an objective to delineate the potential zones of base metal mineralisation. Mineralisation was observed in Baren Formation, Parautochthonous and Salkhalas. A five-meter-wide zone with a strike length of 15 m comprising sulphide mineralisation (sphalerite) was observed in phyllite of Baren Formation at Kanderwan. A zone of sphalerite mineralisation in the form of veins and stringers was noticed within Baren phyllite with a dimension of 3 m width and 25 m

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Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
			length at north of Datta Mandir. At Sillipathri, a 3 m wide and 12 m long zone comprising chalcocite & bornite was observed in quartzite. Besides sulphide mineralisation, discontinuous bands of gypsum and graphite were observed at Bagna, Salamabad, Bijhama, Moriyan and Limber, respectively. Chemical analysis results showed significant values of Pb-Zn mineralisation and manganese. Chemical analysis of samples showed Pb values ranging from 1.28% to 3.4% and Zn values ranging from 1.74% to 5.0. Samples collected from Carbonaceous Phyllite showed vanadium as 990 mg/kg.
Telengana			
Nalgonda	Devatpalli block	Mapping	Reconnaissance G4 stage survey involved mapping of 100.0 sq km area on 1:12,500 scale. The sulphide mineralisation is mainly confined to brecciated and leached pegmatites and quartz veins. The sulphide minerals observed mainly in field area are pyrite, chalcopyrite and occasional covellite and bornite. Base metal mineralisation was found to occur in disseminated form, in small pockets as patchy form and as fracture filling. Based on received analytical results, maximum value for Cu is 7,775 ppm (0.77%) which is recorded from southern most part of study area.
	Keshamnenipalle-Thungathurthy block	Mapping, Geophysical survey & sampling	During reconnaissance G4 stage investigation, an area of 125.0 sq km was mapped on 1:12,500 scale along with integrated geophysical survey of 45 L km and geochemical sampling. Mineralisation in the area was found in the form of disseminated specs of pyrite, chalcopyrite, malachite, covellite, bornite and rare galena within meta-basalt, meta-rhyolite and mafic-rich granite. These sulphides were mainly noticed along very thin quartz-epidote/quartz-carbonate veinlets. The geochemical results received so far showed a maximum 0.13% Cu value.
Andhra Pradesh			
Nellore	Peddarajupalem and Bodavuladinne area	Mapping & sampling	During reconnaissance G4 stage survey, an area of 103.0 sq km was mapped on 1:12,500 scale. The mineralised quartz vein of 100.0 m length was recorded in Timmarajupalle area. Fresh copper sulphides in the form of chalcopyrite has been noticed both as disseminated form within the meta-basalt as well as secondary fillings in amygdules. A 150.0 m long and 50.0 m wide, potential mineralised zone of epidotised meta-basalt hosting the sulphide specks has been identified for base metal exploration and channel bedrock sampling was carried out in this zone. Analytical result of 48 BRS samples showed Cu values ranging from 5 to 628 ppm. The mineralised zone is highly altered.
	Kottapeta and Jangalapalle area	Mapping & Sampling	During reconnaissance G4 level investigation, an area of 103.0 sq km was covered by large-scale mapping on 1:12,500 scale in two blocks i.e. (contd)

Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
			Jangalapalle block (55.0 sq km) and Kottapeta block (48.0 sq km). In Jangalapalle block, incidence of sulphide mineralisation is mostly noticed in approximately 3.5 km long and 0.6 km wide area in meta-basalt. Primary sulphides, such as, disseminated chalcopyrite, bornite, pyrite and secondary sulphides like covellite, malachite and azurite are observed. In Kottapeta block, mineralisation was observed in the form of disseminated sulphides (pyrite, chalcopyrite), approximately over a 150 m long and 6-8 m wide area in south of Village Kottapeta. In Yerakullu Reserved Forest area, sulphide (chalcopyrite, bornite) bearing volcanic rock was observed. In Jangalapalle block, the high copper values of 0.11% to 0.27% were recorded from 12 channel BRS samples. In Kottapeta block, encouraging copper values of 0.10% to 0.64% have been recorded from 08 channel and 02 bed-rock samples.
	Masayapeta block	Sampling	During the course of G3 level investigation, disseminated copper sulphide minerals (viz. chalcopyrite, covellite and digenite) and malachite stains were observed in the old working area. The sulphide-bearing ferruginous quartzite was observed to be discontinuous in nature and was exposed in a few areas. Systematic channel-cum-chip samples were collected from old working across the ferruginous quartzite (plus fresh copper sulphide) and quartz-chlorite-sericite schist (plus malachite). However, on the basis of field observations and analytical results, it seemed that the 10 to 15 m wide ferruginous quartzite with contact zone of schist did have anomalous copper value (ranging from 400 to 5,721 ppm).
Kadapa	Siddhavattam and Vontimitta areas	Mapping & Sampling	During reconnaissance G4 stage survey, geological mapping on 1:12,500 scale of 100.0 sq km area was carried. A number of dolomite bands were found to host sulphide mineralisation with visible specks of galena and sphalerite. The strike length of the individual dolomite bands was found to vary and extended up to 2.8 km. Chemical analyses of the samples of mineralised dolomite bands showed Pb (10 ppm to 3.84%), Zn (25 ppm to 12%), and Cu (10 ppm to 0.28%). Petrological, ore microscopic and X-ray diffraction studies also confirmed the presence of sphalerite, hemimorphite, smithsonite and baryte in dolomite samples. On the basis of field observations and encouraging chemical results, four potential blocks, i.e., Mittapalle block (1.2 sq km), Jaukulapalle block (1.0 sq km), Balayya Kunta block (2.50 sq km) and Narvakatipalle block (4.58 sq km) of sulphide mineralisation were identified in the study area. Based on preliminary findings, Mittapalle and Jaukulapalle blocks have been identified for G-3 stage exploration.

(contd)

Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
Karnataka			
Raichur	Machanur Central block	Drilling & Samplig	General (G2) level of exploration was carried in the area. A cumulative 3,227.0 m drilling was completed in 14 boreholes. The mineralised zone in Machanur that stretched for about 5 km in length and 50-150 m in width within pink porphyritic granite was identified. All the drilled boreholes have intersected disseminated and vein-type mineralisation associated with the breccia zone. The mineralised zones were generally wide, with a maximum width of 90.0 m with Cu up to 3.0% (VE). Analytical results for gold were awaited for all the boreholes except one borehole. In one borehole, only gold mineralisation was intersected i.e. (i) 0.2 g/t Au × 24.4 m, (ii) 0.1 g/t Au × 4.35 m and (iii) 1.0 g/t Au × 3 m. The resource will be calculated after receipt of the analytical results of copper for all the drilled boreholes.
Tamil Nadu			
Villupuram and Thiruvanamalai	Mamandur Polymetal Prospect	Mapping, Geophysical survey, Pitting / Trenching & Sampling	A G4 stage investigation in the area involved Large-Scale Mapping of 100 sq. km on 1:12,500 scale, geophysical survey of 85 L km, pitting/ trenching of 100.0 cu. m along with collection a total of 100 samples. Charnockite and migmatite were observed as the two major lithologies in the area. A number of oxidised/ limonitised zones have been mapped near Vadamamandur and SE of Suttamalai. The ore minerals like pyrite, chalcopyrite, malachite and arsenopyrite were observed in these zones. Malachite and azurite stains were noticed near Mamandur prospect and Kangiyanur. Based on the geophysical survey anomalies in Porassapattu area, two anomalous zones were identified.
Rajasthan			
Alwar	Agar block, Thanagazi teshil	Drilling & Sampling	During preliminary exploration surface manifestations of copper mineralisation were observed in the form of presence of fresh sulphides and native Cu in the protore material, and ferruginisation and brecciatation were also observed in quartzite and malachite stains in mining dump. The analytical result of 95 core samples of all these three boreholes showed maximum 210 ppm Cu. In Agar block, analytical results of core samples showed insignificant value of base metals and precious metals.
	Bhigota block, Rajgarh teshil	Drilling & Sampling	Preliminary G3 level investigation was carried in Bhigota block, Rajgarh teshil. Surface indications of mineralisation were seen manifested in the form of malachite staining and presence of fresh sulphides like pyrite, chalcopyrite and chalcocite mainly in white siliceous dolomitic marble was observed. One mineralised zone was delineated within white siliceous dolomitic marble for 800 m strike length with width varying from 10 to 85 m. The analytical result of the bedrock samples indicate occurrences of Cu (<10 to 9,800 ppm),

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Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
			Co (<15 to 302 ppm), Ni (<15 to 507 ppm), Pb (<25 to 110 ppm), Zn (<15 to 630 ppm), Ag (<5 ppm) Cd (<5 ppm) and Au (<0.05 to 0.14 ppm).
	Tatarpur block,	Drilling & Sampling	During preliminary G3 level of exploration, a total of 529.1 m were drilled in 04 boreholes at 200.0 m spacing along the strike for 60 m vertical intersection of ore zones. Copper mineralisation observed was mainly associated with hornblende-epidote gneiss and amphibolites. Out of 71 core samples, one sample showed 0.13% of Cu as the maximum value. The analytical results of core samples received so far were not encouraging.
	Gor Pahari area	Mapping & Sampling	During reconnaissance G4 level exploration, Large-Scale Mapping of 50.0 sq. km area on 1:12,500 scale was carried out. A total of 144 samples were collected for assessment of base metal mineralisation and associated precious metals in the area. Encouraging base metal values were not reported in the result from the first two lots of samples.
Sikar	Southern Extension of Toda-Ramliyas block	Drilling & Sampling	During preliminary G3 level investigation, a total of 07 first level boreholes and 02 second level boreholes were drilled in the block to test the strike and depth continuity of surface mineralised zone. The petrographic studies revealed that the main copper ore minerals are bornite, chalcocite, chalcopyrite and occasional covellite. The host rock for mineralisation in the area is banded impure marble, amphibole-bearing marble with occasional scapolite. The analytical results from the Boreholes RSTR-01, 03 and 04 have indicated copper lodes with grade varying from 0.24% to 0.42%. The analytical results of Boreholes RSTR- 02, 05 and 06 have not indicated significant sulphide zones.
	Adharshila-Dariba, Neem ka Thana	Drilling & Sampling	Preliminary G3 level exploration involved detailed mapping (1:2,000 scale), surface sampling and geophysical survey of 20 L.km. The surface indications of mineralisation in the block were seen to be present in the form of malachite stains and fresh sulphides i.e., chalcocite, bornite, chalcopyrite and pyrite in impure banded dolomitic marble as well as in quartz veins. Two mineralised zones were delineated on the basis of surface indications of mineralisation within impure banded dolomitic marble. The strike length of one mineralised zone was found to extend for 1,500 m with width varying from 5 to 21 m while other mineralised zone extend for a strike length of about 600 m with width varying from 11 to 66 m. The analytical results of channel samples indicated average copper values varying from 0.13% to 0.56%.
	Daudham-Kalakota block, Neem Ka Thana	Drilling & Sampling	Preliminary G3 level exploration involved detailed mapping (1:2,000 scale) and geophysical survey of 20 L.km. The surface indications of mineralisation were seen to be present in the form

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Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
			of malachite stains and fresh sulphides i.e. chalcopyrite, covellite, bornite, pyrrhotite and pyrite in tremolite-bearing dolomitic marble, siliceous marble, amphibole-bearing dolomitic marble, amphibole quartz biotite schist dolomitic marbles as well as in quartz veins. Three mineralisation zones MZ-I, MZ-II and MZ-III were delineated. The geophysical anomaly showed presence of sulphide mineralisation in the western part of the mapped area. The MZ- I zone was estimated to be 500.0 m in strike length and 2m wide with average grade varying from 0.10% to 0.24% Cu. The MZ-II was found to be 600 m in strike length and 2-5 m wide with grade varying from 0.10% to 0.15% Cu. The MZ-III is 300 m in strike length and 2-5m wide with average grade varying from 0.10% to 0.16% Cu. Two grab bedrock samples from an old mine dump indicated 0.12 ppm and 0.09 ppm of Au values in the block.
	Nathuwala block	Drilling & Sampling	During preliminary (G3 stage) exploration, 04 second level boreholes that involved drilling of 860.0 m with 200.0 m spacing were carried out. These second level boreholes were planned to test the depth continuity of the Cu zone. A total of 2,065.0 m drilling were carried out in 11 boreholes. All second level boreholes have intersected sulphide mineralisation. The cumulative strike length of the mineralised zone was 800.0 m with thickness varying from 2.0 to 21.0 m along the borehole. The analytical results of samples from the Borehole RJNW-10 indicated three copper lodes with width of 2.0 m to 3.0 m and grade that varie from 0.27% to 0.40 Cu at 0.2% cut off. The analytical results of samples from Borehole RJNW-11 indicated one copper lode of 2 m width with 0.21% Cu at 0.2% cut off.
	Chaukri-Bamarana area	Mapping & Sampling	During preliminary G3 level of exploration, an area of 1.50 sq. km was mapped on 1:2,000 scale. Surface indications of copper mineralisation weres observed in the form of malachite stains at only few random places and within scree and dump material. The analytical results of channel samples showed copper values ranging from 50 ppm to 0.36%. Part of the analytical results of bedrock samples were received and only one bedrock sample showed 0.3% Cu value while the Cu value ranges in the other bedrock samples varied from <10 ppm to 988 ppm. The received analytical results of channel samples and bedrock samples did not show encouraging copper values.
	Khora Central block, Bhudoli-Basari area, Nim Ka Thana	Drilling	A G3 stage preliminary exploration for base metal mineralisation in Khora Central block, Bhudoli-Basari area, Nim Ka Thana was carried out. The surface evidences of mineralisation were observed to be in the form of malachite stains. Occurrences of chalcocite, bornite and azurite as dissemination and vein filling were also noticed. The investigation has established the occurrence of

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State/District	Name of block	Details of exploration	Results
			sub-surface copper mineralisation which is hosted by banded impure marble. All the boreholes drilled intersected copper and sulphide mineralisation. The dominant ore minerals intersected in the boreholes are chalcocite, chalcopyrite occasionally with bornite. Mineralisation mostly occurs in the form of disseminations, vein and fracture fillings.
	Kalamara block, Bhudoli- Basari area, Nim Ka Thana	Mapping & Sampling	A G3 level preliminary exploration in Kalamara block, Bhudoli-Basari area, Nim Ka Thana was taken up to delineate the zones of base metal mineralisation. A detailed geological mapping was carried out over an area of 1.27 sq. km on 1:2,000 scale along with sampling. Banded impure marble of the Kushalgarh Formation is the main rock type exposed and host copper mineralisation in the form of malachite, bornite and chalcocite. Two mineralised zones were identified and drilling will be taken up in subsequent year.
	Ravji Ki Dhani area, Nim Ka Thana	Mapping & Sampling	During G3 level preliminary exploration for base metal in Ravji Ki Dhani area, a detailed geological mapping was carried out over an area of 1.8 sq. km on 1: 2,000 scale along with different types of sampling. Copper mineralisation is observed in the form of malachite stains and disseminations of pyrite, chalcopyrite, bornite and chalcocite. At some places quartz veins intruded into amphibole marble along and across the strike also carry disseminated bornite and chalcocite. Three mineralised zones were delineated in amphibole marble. The area will be taken up for drilling in subsequent year.
Alwar and Dausa	Kaled area	Drilling & Sampling	Preliminary (G3 stage) exploration in the area involved mapping of 1.5 sq. km area on 1:2,000 scale along with systematic grid sampling. Analytical result showed Cu value from 0.09% to 3.50% and 08 samples showed Au value from 0.06 to 0.25 ppm.
Nagaur	Dodiyana area	Mapping & Sampling	Reconnaissance G4 level investigation in the area involved mapping of 100.0 sq. km area on 1:12,500 scale, 50 cu.m of pitting/trenching along with collection and analysis of a total of 172 (BRS-112 PTS-50 PCS-10) samples to trace the base metal potential of the area and to delineate the extant of ore body. In the present area, mineralisation is observed in the form of chalcopyrite and bornite specks.
Jhunjhunu	Goriyan block	Mapping, Geophysical survey & Sampling	During preliminary (G3 level) exploration, detailed geological mapping of 1.0 sq km area on 1:2,000 scale and geophysical survey with 20 L km were carried out to understand the physical behaviour of lithology, structures and control of mineralisation in the study area. The manifestations of copper mineralisation were observed mainly in brecciated ferruginised/ gossanised quartzite and occurrences of iron, zinc

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Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
			and gold were also reported in this unit. One mineralised zone was delineated. The channel samples analysed a maximum of 0.68% Cu with 23 m × 0.27 % Cu and the mineralised zone was seen extending to a strike length of about 50.0 m on the eastern side.
	Karmari block	Mapping & Geophysical survey	During reconnaissance G4 stage survey, large-scale mapping in an area of 50 sq km on 1:12,500 scale, 19.4 L.km ground geophysical survey and 440.55 m of borehole geophysical logging were carried out. Potential for base metal mineralisation was seen manifested by surficial malachite stainings and old workings. A well-defined skarn zone was seen present in the eastern contact of the granite with calc-silicate rocks which is a favourable locale for base metal mineralisation. The important zones of mineralisation were found confined to quartzite, garnet-biotite-schist, calc-silicate and Babai granite.
	Manaksas-Norangpura area	Mapping & Sampling	During reconnaissance G4 stage investigation, an area of about 100.0 sq km on 1:12,500 scale was mapped. Gossans were observed on the hill tops of Ajabgarh sedimentaries. The analytical results of 70 samples of the mapped area indicated Cu values ranging from 6 ppm to 0.1%, Co value from <15 ppm to 171 ppm, Ni value from <15 ppm to 152 ppm, Zn value from 9 ppm to 222 ppm and Pb value as <25 ppm. The analytical result of the study area showed much variation in total copper values which was found varying in different rock types.
Ajmer & Pali	Asan-Gafa block	Mapping & Sampling	During reconnaissance G4 level of investigation, an area of 100.0 sq km was covered by large-scale mapping on 1:12,500 scale. Surface evidence of base metal mineralisation, such as, gossan, old workings, slag heaps, malachite and azurite staining were noticed in the areas of Gafa, Charpalan, Dhikan north and Asan village. Primary sulphide minerals, such as, pyrite, chalcopyrite, bornite and sphalerite were seen in the bedrocks of these areas. In Gafa area, two gossan zones each around 700 metre in length was noticed. In Dhikan-Asan area, a discontinuous gossan zone altogether around 1,200 m in length was observed. The bedrock adjacent to the gossan zones contained specs of Chalcopyrite and Bornite. The analytical results received showed spot value of copper as high as 2.31% and for Zn 720 ppm. These values are very sporadic in nature and do not form any zone. The analytical results of 26 channel samples signify value of copper ranging from 0.10% to 1.10% in 10 m.

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State/District	Name of block	Details of exploration	Results
	Barakhan-Sarupa area	Mapping, Pitting/Trenching & Sampling	During G4 stage reconnaissance survey, an area of 100.0 sq km on 1:12,500 scale was mapped. Sporadic occurrence of malachite staining was recorded at four. locations in the calc silicates of Ajmer Formation biotite gnesis of Kotra Formation and meta-intrusive amphibilte within Kotra Formation. Analytical results of 96 bedrock and 20 pitting and trenching samples indicated that value of copper and other associated minerals varie from less than 10 ppm to 3,700 ppm. However, the samples that showed higher values of Cu were collected from isolated malachite-stained horizons and no lateral continuity of mineralised zone could be demarcated. The Barakhan-Sarupa block showed indications of low potential for base metal mineralisation.
Bhilwara	Suwana block	Mapping	Reconnaissance G4 stage reconnaissance survey involved Large-Scale Mapping of an area of 100.0 sq. km on 1:12,500 scale. A few occurrences of pegmatites and quartz veins were recorded in the area. The surface indication of base metal mineralisation has been manifested as malachite stains recorded from amphibolite. However, sub-surface mineralisation is evidenced as specks of pyrite and chalcopyrite recorded from dug well samples of amphibolite.
	Kesarpura block	Mapping & Sampling	Preliminary G3 level exploration in the area comprised detailed geological mapping of 1.5 sq. km on 1:2,000 scale. Mineralisation was observed in the form of ferruginised quartz veins and profuse malachite stains in the quartzite. Fresh sulphides, such as, chalcopyrite, pyrite, pyrrhotite, bornite and covellite were noticed in the area. The analytical results of 53 bedrock samples revealed <25 ppm Pb, <5 ppm to 45 ppm Zn and <5 ppm to 0.2% Cu in the quartzitic rock. The analytical results of 59 channel samples showed <25 ppm Pb, <5 ppm to 62 ppm Zn and 5 ppm to 0.2 % Cu values.
	Urja Ka Khera area	Mapping, Geophysical survey, Drilling, Pitting/Trenching & Sampling	Preliminary G3 level exploration in the area comprised detailed geological mapping of 2.0 sq. km on 1:2,000 scale, pitting/trenching of 50.0 cu m, 26 L.km ground geophysical survey and collection of 125 samples. Fifty samples each of pitting/ trench and bedrock were analysed to assess the potential of Pb, Zn and associated base metals in the area. Cumulatively, 593.25 m drilling in four boreholes were completed.
	Rampura	Mapping & Sampling	During reconnaissance G4 stage investigation, Large-Scale Geological Mapping on 1:12,500 scale covering an area of 100 sq. km was carried out. The analytical results of 11 bedrock samples showed 0.01 % to 0.36 % Pb, 0.002 % to 0.17 % Zn and 0.004 % to 0.087 Cu within calc-amphibole-garnet-magnetitic rock. In Khamor area, analytical results of channel samples have

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State/District	Name of block	Details of exploration	Results
			indicated 0.11 % to 0.16% Pb, 310 ppm to 600 ppm Zn and 220 ppm to 310 ppm Cu only within calc-amphibole-garnet-magnetitic rock. Similarly, in kalyanpura area, analytical results of channel samples have indicated 0.14 % to 0.62% Pb, 0.11 % to 0.14% Zn and 210 ppm to 590 ppm Cu. The integrated geophysical survey was completed covering an area of 2 sq. km within the desired block which delineated a conductive causative body in western part of the area.
	Shivpura and Madera area, South area of Agucha	Mapping & Sampling	During reconnaissance G4 stage survey, Large-Scale Mapping was carried out on 1:12,500 scale covering an area of 100 sq km in the study area. A 100.0 m strike length oxidised zone with 4.0 to 5.0 m thickness (width) was noticed near Madera temple showing Cr concentration up 1,165 ppm. Another mineralised zone having 6.0 to 7.0 m thickness (width) with 500.0 to 700.0 m strike length was observed near Madera hill showing good concentration of Cr values ranging from 600 to 1,200 ppm in association with Cu ranging from 500 to 600 ppm. Chemical analysis results of some bedrock samples has revealed Cr, Cu, Zn and Pb values to be ranging from 600 to 1,200 ppm, 10 to 599 ppm, 10 to 362 ppm and > 2 to 25 ppm, respectively. In soil samples Cu, Zn and Pb values were found ranging from 20 to 50 ppm, 25 to 55 ppm and < 25 ppm, respectively.
	Raipur and Mokhampura areas	Mapping & Sampling	During G4 stage reconnaissance survey, an area of 50.0 sq km was taken up for Large-Scale Mapping on 1:12,500 scale in the study area. In the central part of the study area, surface manifestations of copper was noticed within the amphibolites in the form of malachite staining and fresh specks of pyrite and chalcopyrite along the quartz veins. The chemical analytical data of 08 random bedrock samples out of 42 samples collected from the amphibolites showed anomalous Cu values ranging from 0.1% to 0.25%, however, the Cu values of the 42 bedrock samples varied from 105 ppm to 0.25% with an average of 632.85ppm. Only one channel sample (CHS-1-8) out of 189 channel samples collected from amphibolites near north of Sagrev area showed 0.10% Cu value, however, the Cu values of the 189 nos. of channel samples varied from 15 ppm to 0.1% with an average of 139.80 ppm. Statistical analysis of the bedrock and channel samples have been carried out which indicated a good positive correlation (0.7) between Ni and Co; however, the other elements did not show any good correlation.
	Malikhera, Pur-banera belt	Mapping	The work carried out includes Large-Scale Mapping of 100 sq. km on 1:12,500 scale. Mineralisation in the study area was mainly present in the form of BIF bands, malachite staining within the amphibole quartzite. Banded

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State/District	Name of block	Details of exploration	Results
			iron formation (BMQ) was seen to be present as thin discontinuous bands at the peak of Kamalpura hills in south of Banera. Amphibole quartzite which showed extensive malachite staining and encouraging copper value near Village Manpura was the most promising from mineralisation point of view.
Bhilwara and Ajmer	Kanei Kalan block	Mapping & Sampling	During G4 stage reconnaissance survey, Large-Scale Geological Mapping of 100.0 sq. km area on a scale of 1:12,500 was carried out in the study area. Base metal mineralisation was observed within quartz veins found in the northeast of Village Kachariya and within hornblende gneisses to the east and northeast of Village Kheri. However, the mineralisation was found to be disseminated in nature and occurs sporadically. Out of 10 BRS samples, 02 samples have recorded significant Cu values (0.19% Cu & 0.16% respectively).
	Deolia block	Mapping	During G4 stage reconnaissance survey, an area of 100.0 sq. km was mapped on 1:12,500 scale. The study area forms a part of Sandmata Complex. The mineralisation was seen to be manifested by the presence of fresh sulphide i.e. pyrite, chalcopyrite pyrrhotite, bornite, arsenopyrite and covellite. Specks of mineralisation were also noticed in dug well samples from Bagrai, Devkhera, Ghanera, south of Mataji ka khera area. Sulphide mineralisation seened to occur as disseminated and fracture filling.
Jhunjhunu	Goriyan block	Mapping, Geophysical survey & Sampling	A G4 stage investigation involved Large-Scale Mapping covering 100 sq km area on 1:12,500 scale, 52.0 cu. m of pitting in south and southwest of Village Champaneri along with the collection of 52 samples.
Chittorgarh	Gangrar block	Mapping & Sampling	During G4 stage reconnaissance survey for base metal and associated mineralisation, Large-Scale Geological Mapping on 1:12,500 scale in an area of 100.0 sq. km was carried out. Surface evidences of mineralisation in the form of malachite stains, limonitisation, ferruginous encrustation, old workings with specks of primary sulphides (chalcopyrite, pyrite, and bornite) in the quartzite of the Lasaria Formation was noticed. A total of 06 grab bedrock samples collected during the study have analysed Cu values ranging from 0.11% to 0.70%.
	Khuntiya block	Mapping & Sampling	During reconnaissance survey G4 stage for base metal and associated mineralisation, Large-Scale Geological Mapping of the study area was carried out. Some of the bedrock samples collected during the course of mapping have analysed 340 ppm of Zn, 495 ppm of Pb and 570 ppm of Cu values.

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Table - 5 (contd)

State/District	Name of block	Details of exploration	Results
	Jashma block	Drilling	A G3 level preliminary exploration work comprised deeper drilling to explore the deep-seated base metal mineralisation as reported in the previously drilled boreholes by DMG, Rajasthan in Jashma block. A total of 4 boreholes were drilled to a cumulative depth of 1,418.0 m with depth ranging from 275.0 to 400.0 m. The area of investigation was seen to be devoid of any surface manifestation of mineralisation. A borehole intersected carbonate unit at the depth of 243.0 - 247.0 m which is the main host rock in adjacent Sindesar ridge area for Pb-Zn-Ag mineralisation. Sulphide mineralisation was intersected in the form of pyrite, pyrrhotite and chalcopyrite hosted in graphite mica schist at the depth of 111.0 m, 156.0 m and 219.0 m, respectively. Dissemination, stringers of chalcopyrite, covellite with pyrite and pyrhotite was observed along with sphalerite in other borehole also.
Rajsamand	Kalinjar block	Mapping & Sampling	During reconnaissance survey G4 stage for base metal and associated mineralisation, large-scale geological mapping of 100.0 sq. km area on 1:12,500 scale was carried out. Surface indications of mineralisation, such as, malachite, azurite stains, limonitisation, and ferruginisation/ oxidation along with specks of chalcopyrite, pyrite, bornite and some silver colour have been observed at several places. Bedrock samples collected from migmatite gneiss showed value of 0.55% Cu. Some of the samples collected from albitite vein in fuchsite quartzite (dimension 250 m × 25 m) analysed Cu value of 0.34%. A grab bedrock sample collected near Chechion ki Bhagal analysed anomalous values of 0.37% Cr and 0.11% Ni.
	Shambupura block	Mapping	G4 stage reconnaissance survey for base metal and associated mineralisation in the area involved large-scale mapping of 100.0 sq. km area on 1:12,500 scale. Surface indication of mineralisation in the form of sulphide stains and fresh sulphides were observed in amphibolite. Chalcopyrite, bornite, pyrrhotite and pyrite were the dominant ore minerals observed in this area. Based on the presence of sulphides four potential Cu mineralised zones were demarcated at (i) Kaunwariya-Khakliyakhera area, (ii) NW of Pipli Ahiran, (iii) West of Pipli Ahiran area and (iv) NW of Pipli Acharyan.
Udaipur	Ladana Diggi block	Drilling & Sampling	During G2 level general exploration, a total of 8 boreholes were drilled to a cumulative depth of 1,385.75 m. The mineralisation was noticed in a brittle shear zone within the Untala Granite. Major copper mineral observed here is chalcopyrite which is found as fine dissemination and fracture filled stringers within silicified granite, granite gneiss, etc and the associated sulphides included pyrite and pyrrhotite. Pyrite was seen to be present all along the drill cores. Details of copper lodes intersected in boreholes are as under: RJLD-1: 5.05 m x 0.35% Cu and 10.85 x 0.26% Cu; RJLD-3: 11.05 m x 0.97% Cu; RJLD-4: 2.00 m x 0.48% Cu, 2.10 m x

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Table - 5 (concld)

State/District	Name of block	Details of exploration	Results
			0.40% Cu and 2.20 m x 0.66% Cu; RJLD-5: 4.35 m x 0.38% Cu and 2.75 m x 0.26% Cu; RJLD-7: 14.00 m x 0.20% Cu, 37.95 m x 0.30 to 3.00% Cu, 5.50 m x 0.20% Cu, 10.50 m x 0.20% Cu, 10.00 m x 0.20% Cu (VE). The total resource up to 120 m vertical depth estimated was at about 1.6 million tonnes with 0.68 % Cu at 0.2% cut-off.
	Ladana North block	Mapping & Sampling	During preliminary G3 level exploration for copper and associated mineralisation, a total of 1.6 sq km area were mapped on 1:2,000 scale. The mineralisation in the area was seen mainly confined to amphibolite and ferruginised quartz veins. One zone of mineralisation has been demarcated based upon visible specks of chalcopyrite and malachite stains in quartz veins adjacent to amphibolite dyke. Copper values in one channel varied from 250 to 540 ppm. One grid bedrock sample from mineralised zone had given a Cu value of 0.9%. Another grid bedrock analysed a Cu value of >0.5%. Chalcopyrite was established as the major Cu ore mineral in this block.
	Khori Mahuri area	Mapping & Geophysical Survey	Preliminary G3 level exploration for copper and gold mineralisation in Khori Mahuri area involved detailed mapping of an area of 1.5 sq km on 1:2,000 scale and geophysical survey of 20 L.km Encouraging geophysical anomalies in the form of high chargeability, low resistivity, low SP and high bipolar magnetic anomaly were recorded over dolomitic marble band and surface indications affirms promising Cu mineralisation.
	Jharol block	Mapping	Reconnaissance G4 stage survey for base metal and associated Ni, Cr mineralisation in Jharol block involved mapping of 105 sq km area on 1:12,500 scale. Indications of Cu mineralisation in the form of malachite stains at the contact of ultramafics and mica-schist were noticed near Sarana, East of Gopir and Sultanji-Ka-Kherwara. Around Kochala, extensive malachite stains were noticed. In Magwas and Sarana also, malachite specks were observed on surfaces of ultramafics. Thin bands of chromite were also been observed within the ultramafics at the northern part of the study area (sporadic occurrence at two places: east of Sarana and north of Gairiyawas).
Gujarat			
Banaskantha	In and around Pirojpura	Mapping, Geophysical survey & Sampling	During reconnaissance survey G4 stage for base metals and associated minerals, mapping of an area of 100.0 sq. km on 1:12,500 scale was carried out. Mineralisation was observed in form of disseminated pyrite, chalcopyrite, galena with intense surface incrustation of sulphides. Analytical results of 12 samples showed concentration of Cu from 0.1% to 0.92%, 13 samples showed concentration of Cu from 500 ppm to 1,000 ppm and 5 samples showed concentration of Pb from 1,000 to 4,150 ppm and Zn from 0.1% to 1.12%. Detailed geophysical survey of 26.9 L km along the suspected mineralised zone indicated Zanzarva and Malana villages as moderately favourable for mineralisation and near Village Dungarpura favourable for base metal mineralisation.

Bauxite

GSI

In Chhattisgarh, Jashpur district, a G4 level reconnaissance survey for bauxite in Chundapat block was taken up which included detailed mapping of 3.5 sq. km on 1:5,000 scale. A total of 67 boreholes were planned in 200 m × 200 m grid pattern with approximately 15 m depth and a total of 36 samples of various types were collected during the survey. Chemical analysis results of 10 BRS samples of bauxite revealed that Al_2O_3 ranged from 34.40 % to 57.06%, SiO_2 0.26% to 4.64%, Fe_2O_3 4.94% to 23.81%, TiO_2 5.79% to 12.92%, LOI 20.38% to 25.42%, Ga 60 ppm to 95 ppm and V 530 ppm to 1616 ppm. While the average value recorded in the area were Al_2O_3 49.44%, SiO_2 1.93%, Fe_2O_3 14.67%, TiO_2 10.35%, LOI 22.8%, Ga 85.7 ppm and V 1016.8 ppm.

In Pandrapat block, a G4 level reconnaissance survey for bauxite was taken up which included detailed mapping of 3.5 sq km on 1:5,000 scale. Chemical analysis results of 10 bedrock samples of bauxite revealed that Al_2O_3 ranged from 50.57% to 57.73%, SiO_2 0.53% to 2.91%, Fe_2O_3 3.43% to 12.80%, TiO_2 8.08% to 10.77%, LOI 25.3% to 28.6%, Ga 68ppm to 116 ppm and V 590 ppm to 1,338 ppm with average value of Al_2O_3 54.703%, SiO_2 1.56%, Fe_2O_3 6.88%, TiO_2 9.43%, LOI 26.7%, Ga 94% and V 887 ppm. These analysis results of bedrock samples of bauxite were found satisfactory for extraction of alumina in beneficiation plant. XRD studies confirmed that gibbsite is the dominant mineral phase in bauxite followed by boehmite and anatase.

In Balrampur district, a G3 level general exploration for bauxite in Chapi block was carried out. An investigation involved 154.0 m of drilling along with processing of 35 core samples. Bauxite was found to occur as discontinuous irregular pockets, boulders and lenses of various dimensions within the laterite and aluminous laterite. Mainly three varieties of bauxite were observed to be present – massive, pisolitic and boulder in the study area. In Chapi block, bauxite was seen to occur at two elevation ranges.

In Surguja district, a G2 level general exploration for bauxite in Murtadand block was taken up. An area of 2.5 sq km was covered by detailed mapping on 1:4,000 scale. Bauxite was found to occur as discontinuous pockets, boulders and lenses of various dimensions within the laterite and aluminous laterite. Sampled ore zone is represented by bauxite, aluminous laterite and laterite with pisolites or pockets of bauxite. Ten surface samples of bauxite yielded up to 57.92% of Al_2O_3 content with an average of 52.54%. Average SiO_2, Fe_2O_3, TiO_2, LOI, Ga and V content analysed in surface samples were 1.86%, 7.96%, 11.23%, 25.01%, 97.3 ppm and 777.2 ppm, respectively. The bulk density of bauxite and aluminous laterite was determined as 1.481 tonnes/cu m and 1.66568 tonnes/cu m3, respectively.

In Bilaspur district, a G4 stage reconnaissance survey for bauxite at and around Baidkhodra was carried out. The area was mapped on 1:12,500 scale. Bauxite and bauxitic laterite have been demarcated for the first time within overall laterite of the existing geological map. Chemical analysis (data received so far) showed values of Al_2O_3 ranging from 21.26 to 54.04 wt%, indicating cement grade mostly. XRD study showed 'Gibbsite' and 'Boehmite' peak (65% to 95%). High values of REE, Ga, V were reported for the first time besides bauxite values. Chemical analysis showed high values of V (514-3008 ppm; UCC 97 ppm) and Ga (33-127 ppm; UCC 17.5 ppm).

In Madhya Pradesh, a G2 level general exploration for bauxite and laterite in Pipariya Mall block, Bajag tehsil, Dindori district involved 500.0 m drilling along with detailed mapping of 5 sq km on 1:5,000 scale. The area forms the NW peripheral part of the Amarkantak plateau of Maikal hill range. The Bauxite deposits within laterite capping occur in the form of pockets, lenses, massive and tabular bodies formed by weathering of basalt. It was found that the area is mostly covered by boulders of aluminous/ ferruginous laterite with very minor occurrences of pisolitic bauxite. No scarp section was present in detailed mapped area so that it could be used to determine extent of leaching and development of bauxite in study area.

In Bihar, a G4 stage reconnaissance survey for bauxite and associated strategic minerals (REE, Ga, Ge, Titanium) in Barhulia-Thadi block, Munger district involved mapping of 100.0 sq. km area on 1:12,500 scale and 323 samples were collected. The development of laterite was noticed in Khapra Pahar, Maira Pahar, Garhiya Pahar and Maira-Thadi area. The bauxitic / aluminous-rich laterites were observed in lateritic profile and more enrichment observed at southern face. The analytical results of 65 pit and bedrock samples showed that value of TiO_2 varied from 0.68 to 4.39%, SiO_2 from 2.84 to 70.12%, Al_2O_3

from 13.3 to 58.42%, Fe_2O_3 from 1.34 to 27.64%, Ga values ranged from 9 to 82 ppm, values of Rb varied from 5 to 307 ppm, Sc from 9 to 36 ppm, Sr from 19 to 116 ppm and Y varied from 34 to 102 ppm.

In Jharkhand, during G3 level preliminary exploration for bauxite and associated minerals (Ti, V, Ga etc.) in and around Dumardih and Tukudih, Latehar district an area of 10.0 sq. km area was covered by detailed mapping on 1:4,000 scale. Several laterite outcrops of massive to pisolitic nature were recorded in the study area. Laterite outcrops were exposed at several places within the study area. The outcrop of ferruginous bauxite is exposed at northeast, east and south of Tumbal village.

In Shisatoli-Basdihi area, a G2 stage general exploration for bauxite and associated minerals (Ti, V, Ga, etc) area involved detailed mapping of 4.00 sq. km on 1:4,000 scale. The mineralised zones of bauxite occur as irregular horizontal lenses or pockets varying in thickness from 1.45 m to 10.50 m. Based on visual estimation, the thickness of the bauxite horizon is around 0.50 to 1.50 m. However, thickness of bauxite zone intersected in the boreholes varies from 1.45 m to 10.50 m with a maximum depth of 18.50 m. The analytical results of the XRD samples showed major amount (>50%) of gibbsite with small amount (>5-20%) of boehmite, anatase, haematite and goethite. In a few samples, goethite is also present as traces (<5%) along with kaolinite and quartz.

In Odisha, during G4 stage reconnaissance survey for bauxite in Saptasajya hill and surrounding areas, Dhenkanal district, a Large-Scale Mapping was carried out in the study area. The area is not promising for bauxite due to absence of lateritic profile in the plateau.

In Meghalaya, a G4 stage reconnaissance survey for aluminous laterite/lateritic bauxite and REE in Wahrinong area and a G2 stage general exploration for aluminous laterite/lateritic bauxite and REE in north-east of Rambrai block, West Khasi Hills district involved mapping of 12.0 sq. km on 1:12,500 scale, collection of a few samples in Wahrinong area and detailed mapping of 0.2 sq. km in Rambrai block. Both the projects were dropped due to law & order problem in the study area.

In Gujarat, a G3 stage preliminary exploration for lateritic bauxite in and around Julrai and Junagiya areas, Kachchh district was carried. Detailed mapping covering an area of 10 sq. km on 1:4,000 scale followed by drilling of 98 m was carried out. Laterite is hard, massive and maroon to brown in colour. Its exposed thickness varies from 0.10 to 2.0 m and in cores its maximum thickness is 4.62 m. Pisolitic and oolitic bauxites were found in the area. Its exposed thickness varies from 1.0 to 13.0 m whereas in cores it is 1.07 to 4 m. Well-developed pisolitic bauxite is exposed in the SE of Julrai. The chemical analysis showed Al_2O_3 content varies from 21.06 to 49.11%, Fe_2O_3 5.93 to 40.21%, SiO_2 varies from 8.09 to 21.60% and TiO_2 varies from 4.10 to 7.02% (in 09 samples). The Total REE content varies from 16.88 to 370.23 ppm in 12 samples.

A G3 stage preliminary exploration for lateritic bauxite in and around Asambiya Nana, Mandvi taluka, western Kachchh district was carried out involving detailed mapping of 1.0 sq km area on 1:4,000 scale. The bauxite occurs as pockets and lenses within the laterite deposits. The strike length of laterite/bauxite band is about 4.9 km with width varying from 160.0 to 730.0 m. Lithologs of 18 boreholes indicated that the thickness of mottled bauxite varies from 0.45 to 2.3 m, laterite varies from 1.2 to 9.2 m, clayey laterite varies from 2.2 m to 4.0 m and that of detrital bauxite varies from 4.2 m to 8.95 m. Chemical analysis result for major oxides of 7 samples showed that the lateritic bauxite is composed of mainly Al_2O_3 (26.0 to 48.1 wt %), SiO_2 (7.51 to 29.54 wt%), Fe_2O_3 (2.10 to 16.83 wt%) and TiO_2 (1.35 to 4.60 wt%). The chondrite-normalised REE patterns of the bauxite horizons from 16 samples showed signatures, such as, enriched LREE, depleted HREE, relatively flat HREE and visible Eu anomalies.

Commissioner of Geology and Mining, Gujarat

During 2019-20, an exploration in Virpur Lusri, Mevasa, Lamba, Mahadevia, Satapara & Nandana Mevasa villages of Devbhumi Dwarka district, Gujarat was taken up with an objective to establish auctionable bauxite mineral resources in the area. During the study, a total of 234 boreholes were drilled to a cumulative depth of 1,313 m and 1,457 samples were collected for chemical analysis. About 66.845 million tonnes reserves/resources were established in the area.

Directorate of Geology and Mining, Chhattisgarh

During 2019-20, G3 level exploration for bauxite in Chendradadar area, Bodla tehsil, Kabirdham

district, Chhattisgarh was carried out. Exploration involved mapping of 1.16 sq. km on 1:4,000 scale; drilling of 359.30 m in 31 borehole and collection and analysis of 365 samples. The total reserved resources estimated under Inferred category was placed at 4.61 million tonnes. In Lurena bauxite block, Mainpat tehsil, Surguja district, an area of 0.16 sq. km was mapped on 1:4,000 scale. A total of 536 samples were collected and analysed. G3 level exploration work is is progress. Reserves/resources were not estimated.

MECL

In Jharkhand, a G2 level exploration in Mahuapattoli-Harduba block, Serandag 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 mapping of 0.604 sq.km on 1:2,000 scale, 206.50 m core drilling in 8 boreholes, 193.80 m vacuum suction drilling in 9 boreholes. A total of 478 samples were collected for various studies/analysis. The total reserves/resources estimated in the block under Indicated category was (i) 0.2354 million tonnes of 42.14% Al_2O_3 and 8.39% SiO_2, ii) 1.1223 million tonnes of 44.63% Al_2O_3 and 2.89% SiO_2, iii) 2.5245 million tonnes of >39.95% Al_2O_3 and 4.34% SiO_2.

In Lohadaga district, a G2 level exploration in Village Maduapat, Kisko block 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 mapping of 0.363 sq.km on 1:2,000 scale, 403.80 m core drilling in 21 boreholes, 299.20 m vacuum suction drilling in 17 boreholes. A total of 952 samples were collected for various studies/analysis.The total reserves/resources estimated in the area was (i) 2.88 million tonnes of >37.26% Al_2O_3 and 3.34% SiO_2, ii) 0.82 million tonnes of >38% Al_2O_3 and <5% SiO_2, iii) 0.44 million tonnes of 44.22% Al_2O_3 and 2.78% SiO_2, iv) 8.89 million tonnes of >31.72% Al_2O_3 and 21.11% SiO_2 for aluminous laterite under Indicated category.

Directorate of Geology and Mining, Maharashtra

During 2019-20, G4/G3 level exploration to locate occurrences of Aluminous-Laterite and bauxite deposit over an area of 27.0 km in Mouje, Kudopi villages, Malvan tehsil, Sindhudurg district, Maharashtra was carried out. A total of 49 samples were collected during the field study.

In Ratnagiri district at Village Sheel Taralwadi, Rajapur tehsil, an area of 40.0 sq. km was mapped on 1:12,500 scale and 0.41 sq. km on 1:5,000 scale. A total of 41 boreholes were drilled to a cumulative depth of 498.5 m and 192 samples were collected and analysed. The plateau top are covered by lalerite. Reserves/resources will be estimated after receiving chemical analysis report. Further exploration of G3/G2 level is being carried in the area.

Chhattisgarh Mineral Development Corporation (CMDC)

In Chhattisgarh, CMDC carried out exploration in four mines, i.e, Kudaridih, Narmadapur and Kamleshwarpur in Surguja district and Sukjhar in Kabirdham district. In Kudaridih mine, exploration comprised geological & geophysical mapping of 3.70 sq. km area on 1:1,000 scale & 3.70 sq. km area, respectively. A total of 255 boreholes were drilled to a cumulative depth of 2,934.0 m. In Narmadapur/Kunia mine, geophysical mapping along with geological mapping of 1.49 km area on 1:1,000 scale was completed. A total of 95 boreholes were drilled to a cumulative depth of 1,061.0 m. In Sukjhar mine, geophysical mapping along with geological mapping of 2.94 km area on 1:1,000 scale was completed. A total of 109 boreholes were drilled to a cumulative depth of 1283.0 m. In Kamleshwarpur mine, geophysical mapping along with geological mapping of 1.47 km area on 1:1,000 scale was completed and a total of 197 boreholes were drilled to a cumulative depth of 2,758.0 m. During the exploration, a total of 3,603 samples were collected. So far in this mine a total of 384 boreholes were drilled to a cumulative depth of 5,588.0 m. The total reserves/resources in Kamleshwarpur block (147.62 hectare) was estimated to be about 4.46 million tonnes under Measured category and 0.70 million tonnes under Indicated category.

Ferrous Minerals

Chromite

GSI

In Bihar, G3 level preliminary exploration for Cr, Ni and PGE in and around Lakrahi and Ganjana villages, Gaya district was carried out. An area of 2 sq. km on 1:1,000 scale was mapped. The variants of mafic-ultramafic rocks did not show any promising result as it indicated insignificant value of < 43 ppb SPGE. The Cr content showed a peak value of 3,200

ppm and Ni of 700 ppm. No PGM phases were observed in any of the samples/rock types.

In Chhattisgarh, a G3 level preliminary exploration was carried out for Cr, Ni and associated PGE mineralisation in Dongripali block, Mahasamund district. Two very small patches of gabbros (nearly 2 m in length and 1 m width) rich with sulphides were observed in the northeastern part of the study area. A total of 66 samples of various types were collected during the course of the fieldwork. Chemical analysis showed that the value of Cr ranged from 132 to 2,575 ppm, Ni 95 to 613 ppm, Cu 9 to 632 ppm and Co 45 to 82 ppm. The Pt, Pd and Ru values were found to range from 6 to 18 ppb, 6 to 35 ppb and 8 to 18 ppb, respectively. No specific zone of mineralisation was demarcated.

In Madhya Pradesh, a reconnaissance survey (G4) was taken up for chromium, nickel and PGE mineralisation in parts of Jobat mafic/ ultramafic suite of rocks in Ranapur-Bhutkhedi-Salarpada-Matasula areas, Jhabua district. An area 50.0 sq km was mapped on 1:12,500 scale. The values for Cr ranges from 345 to 1,500 ppm with highest value (1,500 ppm) recorded in near ChhanSemalKhedi with MgO content as 6.64 wt%. Ni ranges from 145 to 690 ppm, with highest value (690 ppm) recorded near Ranapur with MgO content as 12.47 wt%. Highest concentration of PGE as 35 ppb (Pt 6 ppb and Pd 20 ppb) was recorded from a BRS collected from meta-pyroxenite near Village Samoi Baba Dev with 810 ppm Cr and 420 ppm Ni. Values for Cr as 360-585 ppm and Ni as 150-260 ppm was recorded from a trench near Chhan Semal Khedi. Two distinct bands of BIF were recorded near Baldimal and Chhoti Matasula areas with Fe content around 45 wt% in visual estimation.

In Maharashtra, a G4 stage reconnaissance survey was taken up for chromium, vanadium and associated mineralisation in Ghavnale-Pulas areas of Sindhudurg district. An area of 100.0 sq. km was mapped on 1:12,500 scale. The bedrock samples of gabbronorite and dolerite yielded chromium values ranging from 29 to 3,340 ppm. The analytical data of channel-cum-chip samples of gabbronorite showed Cr values ranging from 43 to 3,196 ppm, vanadium values from 150 ppm to 336 ppm and nickel values between 66 and 847 ppm. The pit samples of gabbronorite showed chromium value ranging from 45 to 3,181 ppm, vanadium ranging from 132 to 338 ppm and nickel values between 43 ppm and 734 ppm. An area of 0.5 sq. km (1.6 km x 0.31 km) was delineated NW of Nilelichiwadi as potential area for Cr and Ni mineralisation.

In Manipur, a G4 stage reconnaissance survey was taken up for chromium, nickel and base metal mineralisation in Gamnom-Yentem area, Ukhrul district. A total of 60.0 sq. km area were mapped on 1:12,500 scale. Chromitites occur in cluster in the form of pods of dimensions ranging from 0.25 to 2.0 m at Gamnom, south of Khangkui Khullen and Pushing. The chemical analysis of chromitite sample from the bodies of small dimensions that occur in cluster within a very limited area indicated Cr_2O_3 (31.1% to 47.51%). The analytical result of peridotites from pitting/ trenching samples showed Cr_2O_3 (0-47.51%), Ni (924-18,580 ppm), Co (151-329 ppm), Cu (<4- 33 ppm), Pb (2-3 ppm) and Zn (35-297 ppm).

In Odisha, a G4 stage reconnaissance survey through integrated geochemical and geophysical survey was taken up for chromite mineralisation in Asurabandha-Bhusal block and Chandar block, Dhenkanal district. Large-Scale Mapping of 80.0 sq. km area on 1:12,500 scale and detailed mapping of 3.0 sq km on 1:2,000 scale were carried out. In Asurabandha-Bhusal block, the Cr concentration of soil samples varied from 59 ppm to 4,983 ppm, Fe_2O_3 from 3.10 % to 21.26%, MgO from 0.31 to 1.45%, Cu from 10 ppm to 259 ppm and Ni from 24 to 663 ppm in the soil samples. As per the analytical result received for Chandarblock, the Cr concentration varied from 177 ppm to 8332 ppm, Fe_2O_3 from 4.02 % to 22.40%, MgO from 0.32 % to 2.94%, Cu concentration from 32 ppm to 152 ppm and Ni from 53 to 647 ppm in the soil samples. Bedrock samples taken from magnetite band showed the values of Fe ranging from Fe 55.44-55.82%, Ti from 8.18 to 9.06 % and the values of vanadium were below the detection limit. From ground geophysical study, 3 anomalous zones in Asurabandha-Bhusal block and one zone in Chandar block were identified.

During G4 stage reconnaissance survey for chromite and associated mineralisation in the Sukinda and Baula-Nuasahi ultramafic complex, Kendujhar and Jajpur districts, an area of 100.0 sq km was mapped on 1:12,500 scale. There are no surface or subsurface indications of chromite mineralisation in the area. However, minor sulphides (pyrite, pyrohtite marked as occasional fine specks and disseminations hosted within ultramafics,

amphibolite and quartzite) were observed in core samples. A total of 40 line-km gravity and magnetic survey and vertical electrical sounding survey at 30 points were carried out. Analytical results of 10 bedrock samples showed Cr value ranging from 968 to 2,947 ppm, out of which 3 samples showed Cr value more than 2,000 ppm. The analytical results of 78 pit/ trench samples showed Cr value ranging from 442 to 3,334 ppm, out of which 16 samples showed Cr value as more than 2,000 ppm.

In Telangana, a G3 stage preliminary exploration was carried out for chromite and PGE mineralisation in Himmamnagar-Vinobhanagar block of the Chimalpahad mafic-ultramafic complex, in parts of Khammam and Bhadradri Kothagudem districts. The study involved detailed mapping and geophysical surveys (gravity and magnetic) in 2.6 sq. km area on 1:2,000 scale. There are 2-3 small bodies of ultramafic outcrops mapped in the block area. Detailed geophysical gravity and radiometric surveys were conducted in 100 m × 100 m grid interval. Analytical results of bedrock samples showed maximum value of Cr_2O_3 as 54.82% and in 25 soil samples, the maximum Cr value recorded was 1,598 ppm.

Directorate of Geology, Odisha

In Odisha, Directorate of Geology has taken up geophysical exploration for chromite in Sarpani and Rainolo villages in Dhenkanal district. Objective of exploration was to delineate anomalous zone for chromite occurrences. Chromite occurs as lenses and pockets in this region. The work included Geophysical Magnetic Survey of 1.5 sq. km area on 50 m × 25 m and Induced Polarisation (IP) survey of 0.28 sq. km on 50 m x 25 m grid. The analysis of IP data and its correlation with magnetic data was in progress.

Iron Ore

GSI

In Andhra Pradesh, reconnaissance survey (G4) for iron ore taken up in Letapalle area, Kadapa district comprised Large-Scale Mapping of 100.0 sq km on 1:12,500 scale. The presence of iron ore was noticed in two pits. Pit-1 found at 300 m SW of Village Letapalle with 200 m × 30 m dimension having thickness of 0.5 to 1 m occurs at a depth of 4 to 5 m below the surface. Haematite ore with 150 to 200 m strike length and 20 to 25 m width in the quarry was found to occur as a band. In Pit-2, the iron (haematite) band was at a depth of, 5-7 m with a thickness of 10 to 20 cm. The mineralisation in the study area is strata bound and lensoidal in nature, thickness was seen varying between 0.1 and 1 m. The iron ore bodies occur within intercalated sequence of shale. Lensoidal iron ore bodies occur at a depth of 4-5 m below the surface in the two pits. The length of mineralised zone was determined as 200-250 m. Analytical chemical result of bedrock samples showed Fe ranging from 35 to 50% and in 20 trench samples, Fe was found ranging from 30 to 45%.

A reconnaissance survey (G4) taken up for iron ore in Nagayapalle-Konduru area of Kadapa district involved large-scale mapping of 100 sq. km area on 1:12,500 scale and 50 cu. m of pitting/trenching. During the current investigation, haematite was seen associated with the quartzite/cherty quartzite and as thin bands associated with the purple shale. The iron ore bands in the upper part have a thickness of a few centimeres to 1 m with limited lateral extension. The iron ore bands are pocket type and discontinuous with limited strike extension. Chemical analyses for 75 bedrock samples showed the value of Fe ranging from 0.31% to 62.72%.

A reconnaissance survey for iron ore in Juvvikunta and Pedda Alvalapadu areas of Nellore schist belt of Prakasam district Andhra Pradesh was taken up. During the study, large-scale mapping (on 1:12,500 scale) in an area of 100.0 sq km was carried out in two blocks that were demarcated as (i) Juvvikunta block (34 sq km.) and (ii) Pedda Alavalapadu block (66 sq km). Two non-significant Banded Magnetite Quartzite (BMQ) bands have been mapped in the northern part of Pedda Alavalapadu block. Iron ore in the area was found to be very thinly laminated magnetite band within silica-rich quartzite band. The strike length of BMQ-I and BMQ-II was reported as 1 km with an average width of 20-25 m and 500 m, respectively. Analytical results of the bedrock samples and trench samples indicated presence of a low-grade magnetite ore in both the BMQ units of the area.

In Prakasam district, a reconnaissance survey (G4) taken up for iron ore in Ayyaavaripalle-Chundi-Malakonda area of Nellore schist belt comprised Large-Scale Mapping of 100.0 sq. km area on 1:12,500 scale. The iron ore exposed in the area was observed as Banded Magnetite Quarzite (BMQ). A total of six low to medium grade BMQ bands were recorded in the two blocks i.e. in southern block 2 bands viz. (i)

South-east of Village Ayyavaripalle (4.5 km × 30 m), (ii) South-east of Ayyavaripalle (800 m × 40 m); in northern block 4 bands viz. (i) west of Ayyavaripalle to north of Village Malakonda (2.5 km × 20 m), (ii) East of Ramalingapuram (1 km × 15 m) (iii) East of Lakshmakkapalle (1.6 km × 40 m), (iv) north of Village Lakshmakkapalle (2.5 km x 40 m). The total Fe content was found ranging from 22% - 44.10 % with an average of 22.71%. The average SiO_2, Al_2O_3 and P_2O_5 percentage of BMQ bands was reported as 49.08%, 7.50% and 0.32%, respectively. The BMQ band observed in the south-east of Village Ayyavaripalle showed the highest total Fe content of 44.10%.

In Chittoor district, a reconnaissance survey (G4) for iron ore in Gadanki block (68 sq km) and Bommayyapalli block (36 sq km) areas was taken up. In Gadanki block, three discontinuous BMQ bands were mapped with cumulative length of around 780 m. BMQ Band-1, WNW of Village Cheruvu Mundari Kandriga, was traced to a cumulative length of 35 m with width of 50 to 60 m. In Kesavakuppam area, two small discontinuous BMQ bands with cumulative length varying from 150 to 200 m and width of 40-50 m were also mapped. Only two small outcrops of BMQ (5m ×1m ×1m) could be traced near Village Telagundlapalle in Bommayyapalli block. The visual estimation indicate iron to silica ratio varies from 1:2 to 1:5. The bedrock samples in the Gadanki area showed that most of the samples contain silica in the range of 33-60% and Fe content in the range from 8% to 40% with mean value of 28.67%.

In Anantapur district, a general exploration (G2) for iron ore was carried out around Obulapuram area. Iron ore was reported mainly as Banded Magnetite Quartzite (BMQ) and Banded Haematite Quartzite (BHQ) in the area. Three prospecting blocks, i.e., Block-1: 0.52 sq. km, Block-2: 1.64 sq. km and Block-3: 3.84 sq. km were identified for drilling during the detailed mapping. In block-1, iron bands were categorised under massive haematite ore (64% to 65% Fe; length: ~450 m, width varying from 3 to 40 m), friable haematite ore (55% to 64% Fe, length ~550 m, width varying from 20 to 200 m) and alternate bands of haematite and argillite (47 to 49% Fe; length ~200 m, width varying from 20-50 m). In Block-2, BMQ bands recorded to be 1.5 km in length with width varying from 10 to 60 m showed 30-40% Fe. In Block-3, two 5.6 km long BMQ bands were demarcated (width varying from 10 to 40 m) with 25 - 40 % Fe.

In Kurnool district, a preliminary exploration (G3) taken up for iron ore in Veldurthy block of Cuddapah Supergroup comprised of two blocks i.e. Block-1 (0.36 sq. km) and Block-2 (1.64 sq. km). Detailed geological mapping of the two blocks were completed on 1:4,000 scale along with the magnetic and gravity survey. Based on integration of all available exploration collected during study, three mineralised zones i.e. Zone-1, Zone-2 and Zone-3 were demarcated. A total of 202.50 m of drilling were completed in Veldurthy Block-2. Indications of mineralisation were noticed at various depths in the form of thin veinlets of haematite with specks of pyrite associated with fractured quartz vein and dolomite.

In Bihar, general exploration (G2) for magnetite in previously investigated area around Majos, Jamui district was taken up by means of drilling. During 2016-18, resources estimated were at about 19.46 million tonnes with average grade of 36.48% Fe over a strike length of about 2 km. Majority of the study area i.e. Majos block was covered by alluvium. Limited outcrop of BMQ and mica schist were noticed between Majos and Jalai villages. Magnetite occurs mainly in BMQ as thinly bedded/laminated alternating with quartzite and as powdery ore. Boreholes were drilled to intersect ore bodies maintaining the same strike spairy at 2nd level (60 m vertical depth) and at 3rd level (90 m vertical depth).

In Jharkhand, a reconnaissance survey (G4) in an area of 100.0 sq. km for iron ore and manganese ore was taken up in the gap areas near Village Kadaph in the West Singhbhum district. Presence of total of seven mineralised zones were recorded for iron and two for manganese mineralisation. The chemical analysis results of bedrock samples showed iron content varying from as low as below 25% (32 samples) to as high as more than 50% (18 samples). The average Fe (T) content of the iron ore samples was 34.67 %. The Mn content reported in the two bedrock samples was 18% and 14%, respectively. Both the samples were rich in iron content with minimum of 36.46% Fe and 31.43% Fe, respectively.

Preliminary exploration (G3) for iron ore and manganese ore was carried out in the gap areas at Karampada west block, West Singhbhum district. An area of 5.0 sq. km area was mapped on 1:4,000 scale along with line 5 L km gravity and magnetic survey being carried out in the study area. Two iron ore

Table - 6:Exploration for Iron Ore by MECL & NMDC 2019-20

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (ha)	Boreholes	Meterage		
MECL							
Chhattisgarh							
Balod	Dulki block of M/s SAIL	-	-	14	721.00	253	The boreholes drilled are located in active mine benches and hence the exploration programme was mines supportive. Reserves/resources not estimated
	Rajhara mine of M/s SAIL	-	-	08	541.10	57	The boreholes drilled are located in active mine benches and hence the exploration programme was mines supportive. Reserves/resources were not estimated
	Jharandalli mine of M/s SAIL	-	-	7	476.10	193	The boreholes drilled are located in active mine benches and hence the exploration programme was mines supportive. Reserves/resources were not estimated
	Dalli mine of M/s SAIL	-	-	14	721.00	253	The boreholes drilled are located in active mine benches and hence the exploration programme was mines supportive. Reserves/resources were not estimated
NMDC							
Karnataka							
Ballari	Donimalai	-	-	-	-	-	The total reserves/resources as on 1.4.2020 are estimated at about 149 million tonnes in Donimalai mine.
Chhattisgarh							
Dantewada (South Bastar)	Bailadila Iron ore Mines Bacheli D-5	-	-	28	4496.00	-	-
	Bacheli	-	-	17	1471.00	-	-
	Kirandul complex Deposit-11ML	1:2000	-	44	4422.00	1319	The total estimated reserves/ resources as on in Deposit-11ML was placed at about 567 million tonnes.
	Kirandul complex Deposit-14ML	1:2000	322.37	19	1913.00	1456	The total estimated reserves/ resources as on in Deposit-14ML was placed at about 525 million tonnes.
	Kirandul complex Deposit-14 NMZ ML	1:2000	506.74	20	1813.00	1064	The total estimated resources as on in Deposit-14 NMZ was placed at about 306 million tonnes.

(contd)

bands were demarcated in the area. The thicker iron band in north central part has dimension of 1.7 km × 600 m. The second band occurs in the eastern part of the area and has dimension of 1.4 km × 300 m. The chemical analysis revealed 22.03% to 93.04% Fe_2O_3 (T) content in ores. The PTS gives more than 55% Fe_2O_3 (T) in seven samples out of to samples. Varieties of iron ores noticed in this area contain blue dust with 58% to 63% Fe, friable ore with 58% to 65% Fe and lumpy ore with 55% to 65% Fe.

During reconnaissance survey for iron ore and manganese ore in the gap areas near Village Kumdi in the West Singhbhum district, an area of 100.0 sq. km was mapped on 1:12,500 scale along with pitting/ trenching of 100 cu. m. Four bodies of iron ore have been noticed i.e. around Rajabera, South west of Village Kumdi, road section near Sedel and Village Honjoradari of dimensions (2.2 km × 30 m), (400 m × 20 m), (50m × 20 m) and 300 m × 20 m, respectively were recorded in the study area. At Rajabera, the iron ore is mainly hard and massive. Bedrock samples/ trench samples (160 Nos) collected from the area yielded iron in the range of 10.91% to 68.79%. Bedrock samples collected near Rajabera area showed above 60% of Fe, while Mn varied from <0.01 to 3.41%, SiO_2 0.85 to 83.02% and Al_2O_3 0.53 to 6.98%. The average Fe (T) content of the iron ore samples was 43.61%.

Reconnaissance survey (G4) was taken up for iron ore and manganese ore in and around Marang Ponga-Kodalibad-Tholkabad areas of West Singhbhum district. large-scale mapping of 100.0 sq. km area was carried out on 1:12,500 scale. A potential zone of BHQ was identified towards the north-eastern part of the study area near Usaruiyan and Kodalibad villages. The major part of the ore body comprised BHQ. Presence of BMQ was also noticed towards the south of Village Usuriyan, where the ore body was found to be hard laminated (HLO) in nature. Goethite with botryoidal form was noticed in Kodalibad area. The length and width of the potential zone were about 1.40 km and 1.15 km, respectively. A total of 230 samples of various types were collected during the field work. Analytical results of BRS samples (70 Nos) revealed the concentration of Fe_2O_3 (T) in the range between 33.67 and 93.74% with an average of 74.17% and MnO concentration as <0.01 and 2.01% with an average of 0.06%.

In Karnataka, reconnaissance survey (G4) for iron ore in 13/1 north and south blocks, Ramanadurga, Sandur Schist belt, Bellary district, was taken up involving detailed mapping of 0.62 sq. km area on 1:2,000 scale. Samples from forest area could not be collected. During mapping, laterite, iron ore, Banded Haematite Quartzite (BHQ) and shale were delineated. The high-grade iron ore band was roughly 1 km long and 180-260 m wide. As the iron ore band exposed was on steep hill slope, the apparent thickness (180-260 m) of the iron ore band was more as compared to its true thickness. The drilling activity in blocks could not be initiated due to forest clearance issue

In Madhya Pradesh, a preliminary exploration for low-grade iron carried out in Gandhigram block, Sidhi district comprised collection of 40 samples, geophysical survey work of 50 L km each in SP, IP, magnetic survey, resistivity survey and geophysical borehole logging of 124.5 m. Laterites occur as capping with thickness varying from place to place and mainly showing nodular to pisolitic structures with specific gravity varying from light to high. They were interpreted as heavier laterites that are rich in iron and lighter with rich in bauxitic contents. A patch of dolomites was also noticed in the mapped area,The drilling block covered BIF and BIF breccias which showed very thin banding/ compositional layering. The grade of chemogenic sequence falling in the area is of low grade to medium grade having Fe_2O_3 values ranging from 30% to 60% and total Fe content ranging from 21% to 42%.

In Maharashtra, during reconnaissance survey for iron ore in Ambadgaon-Matna area in district Sindhudurg, large-scale mapping for 100.0 sq. km area along with collection of 160 bedrock samples were carried out. The iron mineralisation was indicated in the form of intense ferruginisation, iron encrustation in laterites and presence of iron oxides, such as, magnetite, haematite, goethite and limonite along with manganese mineralisation. In BMQ samples, the maximum value of Fe and Mn was about 54.34% and 8,570 ppm, respectively. Laterite samples showed Fe value as more than 28% and manganese >3,000 ppm. The maximum value of Fe and Mn in laterite was 53.16% and 17.31%, respectively. Pits samples yielded iron value more than 28% and maximum value of 55.12% whereas in case manganese, the maximum value is 15.40 %. The overlay studies have indicated that there are six zones of mineralisation which have

anomalous value of iron along with/without manganese mineralisation. The cumulative area of six zones is 1.09 sq. km which has been delineated as potential area for iron. There is also an area of 1.5 sq. km between Dhat and Ambadgaon which appears to be potential for iron ore where BMQ is having 30.91% (weighted average) Fe content.

In Meghalaya, a preliminary exploration (G3) for iron in the Banded Iron Formation in Nongdom-Langtor area, West Khasi Hills district, involved detailed mapping of 0.8 sq. km of on 1:2,000 scale, mapping of 0.7 sq. km on 1:4,000 scale, collection of 50 BRS, 04 petrological samples and 07 OM samples, 10 PS samples, 48 PTS and 90 cu. m of pitting-trenching. Chemical analyses result of pitting and trenching showed Fe_2O_3 values ranging from 0.73% to 83.38% and Al_2O_3 values ranging from 2.36% to 31.35%, whereas chemical analyses result of bedrock samples showed Fe_2O_3 values ranging from 4.77% to 67.14%.

In Odisha, a reconnaissance survey (G4) was taken up for iron ore in BIF and titanium-vanadium-bearing magnetite ore in Badampahar-Suleipat-Jashipur area, Mayurbhanj district. The study area was divided into Domain-1 and Domain-2 covering 60 sq. km and 40 sq. km area, respectively. In Domain-1, a total of 4 BMQ bands each having strike length of 512 m, 1.3 km, 3.1 km and 3.6 km were delineated. While in Domain-2, two massive magnetite bodies of 281 m and 318 m strike length were delineated near Mayurbeka and Kesam villages. In Domain-1, the average width varied from 20 to 35 m whereas in Domain-2 the average width of massive magnetite bodies was about 50 m. A total of 96 BRS, 10 PCS and 25 PTS were collected from the area. The TiO_2 concentration in Band-1 and 2 is restricted within 0.01%, however, in Band-3 and Band-4 it ranged from 0.01 to 0.06% and 0.01 to 0.02% respectively. V concentration is <20 ppm in all of these four bands.

In Kendujhar district, during preliminary (G3) exploration for iron ore in Kendudihi north block, an area of 1.45 sq. km was mapped on 1:2,000 scale. The ore type in the area is mainly haematite. Manganese ore occurrences were noticed at nala section in the central portion and at old pit in southern part of the block. A total of 242.15 m drilling were completed under G-3 stage at 400 m X 400 m interval. A 30.00 m cumulative thickness of lateritised iron and 8.85 m Mn horizon at 54.75 to 62.60 m depth was intersected in one borehole and 71.20 m thick iron ore was intersected in other borehole. The mineralised zone intersected in the area comprised of lateritised iron ore with minor HLO, SLO, purple powdery ore with intercalations of shale/ferruginous shale and Manganese ore.

During reconnaissance survey for iron and manganese ore in Uliburu area, Keonjhar district, a total of 0.55 sq km area were mapped on 1:2,000 scale and 7.7 sq km area were mapped on 1:5,000 scale. During the course of mapping, numbers of old quarries in the adjacent area were studied to appreciate the disposition of ore bodies and their association with the other rock units. In some quarry sections, the thickness of laterite profile was found varying from 5 to 30 m. Lateritic iron ore exposed in the eastern fringe of the block assayed 40-50% Fe.The block does not hold much promise from the point of view of iron mineralisation except the eastern part of the block.

General exploration (G2) for iron ore float was carried out in Putulipani block, Kendujhar district. Metabasic rocks, iron ore and shale are the major litho variants reported in the block. The slope of the ridge is having float ore accumulation of varying thickness from less than 1 m to as thick as 15 m. Field work for float ore resource estimation was tried with collection of vertical groove samples from mining benches, pit/trench sampling in the non-mined parts, collection of grab samples from the ore stacks left over the mining benches. A total of 35 vertical groove samples, one PTS and 10 grab samples were collected.

General exploration (G2) for iron ore float was carried out in Laupada block, Kendujhar district. As part of this investigation, float ore estimation, pit-trench sampling, vertical groove sampling, grab sampling of the ore stacks was carried out. The area is devoid of mining benches, hence mostly pitting, trenching and PTS sampling was carried out. The float ore thickness is erratic which may be due to uneven ancient valley floor and gradient.

Kendujhar and Sundargarh districts, a general exploration (G2) in Gandhalpada west block was carried over an area of 2.0 sq. km with an objective to assess iron ore potential for augmentation of resource. The iron ore bodies were exposed in the form of hard and soft laminated ore and lateritic ore in the central part of the block. A total of 2,420 m of

drilling was carried out in 24 boreholes at 200 m × 200 m grid interval. Out of 24 boreholes drilled, 19 boreholes intersected ore zones. The cumulative thickness of iron ore zone in the boreholes was found to vary from 15 m to 73 m. The northeastern part of the block is thickly mineralised than the southwestern part. The intersected iron ore zones mainly comprised of powdery iron ore, blue dust, soft laminated ore and some hard-laminated ore/ lumpy iron ore pieces with minor shale intercalations. The ore mineral was mostly haematite with minor amount of goethite and limonite. Besides iron ore, five boreholes have also intersected lignite. The total resource of the block at 45% Fe cut-off was estimated at 53 million tonnes. In addition, tentative resource of lignite estimated, based on the thickness of lignite zone intersected in the boreholes, was 1.346 million tonnes.

In Rajasthan, a preliminary exploration (G3) for appraisal of iron ore in Banol area, Jaipur district was carried out. An area of 1.5 sq. km was mapped on 1:2,000 scale during the study. Detailed mapping demarcated the presence of 2-3 discontinuous bands of iron ore. Some evidences of opencast/underground mining activities were noticed in the form of small pits filled with mine dump. The total strike length of mineralised zone in Band I is about 750 m with an exposed thickness of about 5-10 m in the western limb and 20 m in the eastern limb. The strike length of Band II extended to about 100 m with thickness of approx. 10 m in the western limb. The Fe content in Band I was found to vary from 27.31% to 69.38% while in Band II it varied from 20.74% to 66.08%. The Fe% in total (Nos. 26) of channel samples showed above threshold value of haematite which varies from 55.25 to 69.9%.

A preliminary exploration (G3) for appraisal of iron ore was carried out in Morija area, Jaipur district. Three bands of haematite were demarcated. Band-1 extended for about 1.3 km strike length with thickness of 7 to 30 m. Band-2 had a strike length of 450 m with thickness varying from 6 to 13 m. Kankeria area exposed the shortest band of haematite of 210 m strike length with 6-12 m thickness. Channel samples collected from hinge area showed 6m wide zone with 66.08% Fe (weighted average) while adjacent channel exposed 6 m wide zone with 58.24% Fe value (weighted average). A 90 m long and about 8 m thick zone of albitite was reported for the first time in the area.

In Telangana, during reconnaissance survey (G4) for iron ore (BMQ) was carried out in the Gottugudem-Kondipalle block, in parts of Bhadradri- Kothagudem district, Large-Scale Mapping was carried out in 100.0 sq. km area on 1:12,500 scale. A total of 18 BMQ bands were identified in the block area, out of which 3 BMQ bands were mapped at Gottugudem, Kondipalle and Marrayagudem hillocks. The analytical results for BMQ samples showed Fe_2O_3 values varying from 34 to 53% with an average of 44%.

In Uttar Pradesh, during preliminary exploration (G3) for iron ore in Block 'B' Bharhari area, Sonbhadra district, an area of 2.0 sq. km was mapped on 1:4,000 scale. The banded haematite chert/jasper band forms a continuous band at the hill top with a strike length of 3.12 km and exposed width of 9 m to 54 m. A total of 461.30 m of drilling were carried out in four boreholes and 187 core samples were sent for chemical analysis during the study. Five mineralised zones have been delineate with a cumulative thickness of 32.75 m for 30% Fe cut off and five zones for 35% Fe cut off. The average grade of the Fe at 30% cut off was 35.02% which was only reported in one borehole.

Directorate of Geology and Mining, Maharashtra

During 2019-20, reconnaitery exploration for iron ore was taken up to prove iron ore deposit near village Ekalpur-Wisora in Gadchiroli district. A total of 10.32 sq. km of area were mapped on 1:12,500 scale and 2 scout boreholes were drilled to a cumulative depth of 147.0 m. About 253 samples were collected and analysed. No encouraging results were found in the area. Reserve/resources are yet to be calculated.

In Kharra block, Gondia district, an area of 89.46 sq km was mapped on 1:25,000 scale and 10.00 sq.km area on 1:5,000 scale. Reef of banded haematite quarzite was seen trending north-south direction. The thickness of reef was about 7-10 m. A total of 71 samples were collected during the field study. Further exploration has been proposed in the area.

Directorate of Geology and Mining, Uttar Pradesh

During 2019-20, reconnaitery exploration (G4) for iron ore was taken up to prove iron ore deposit near village Solda-Uldana area in Lalitpur district. About 1.00 sq.km of area was mapped on 1:5,000 scale and 104.5 cu. m material was excavated in 6

pits. A total of 310 samples were collected i.e. 208 grid samples, Besides, 70 pit samples for chemical analysis and 32 grid surface samples for petrological study were collected. Objective of exploration was to delineate the iron ore deposit of Kharna area and to calculate the iron ore reserves/resources. The length of the ore body/ ferruginous body was 850 m with width close to 800 m. Iron ore in the area was found to occur as nodules, pellets and in powdery form as discontinuous lenticular elliptical lenses.

Manganese Ore

GSI

In Andhra Pradesh, a G4 stage reconnaissance survey for manganese mineralisation in Bondapalle and Vegalavalasa was taken up in areas of eastern ghat mobile belt, Srikakulam and Vizianagaram districts. The survey subsumed large-scale mapping of 100.0 sq. km area on 1:12,500 scale. The main manganese-rich band is of nearly 1.0 km strike length with width varying from 5 to 10 m at Village Garraju Cheepurupalli. The dimension of the band is around 200 m × 10 m. The manganese concentration is more in the centre. Other occurrences were also reported at Soper with the dimension of 50 m × 10 m, at west of Rachagumadam with 10 m × 5 m and at Kondalaveru with 30 m × 5 m. Float ores were observed at Gotnandi with a cumulative dimension of 20 m x 5 m. One major manganese ore body with average 9.75% MnO was delineated in G. Cheepurupalli where average MnO value was found to be more than 10%.

A G4 stage reconnaissance survey for manganese mineralisation was also taken up in Perapi-Pattikayalavalasa-Laveru-Gollapalem areas of eastern ghat mobile belt, Srikakulam and Vizianagaram districts. An area of 100 sq km was mapped on 1:12,500 scale. Two promising manganese blocks near Palavalasa and Laxmipuram have been delineated. The manganese mineralisation occurs in the form of bands, lenses and pockets with varied dimensions. The manganese zone of Palavalasa block is of about 400.0 m strike length and 30.0 m width while the manganese zone of Laxmipuram block is about 150.0 m strike length and 20.0 m width. In Palavalasa, MnO values of bedrock samples ranges from 3.59% to 22.09% with an average grade of 10.31%, while in Laxmipuram, MnO value ranges from 3.37% to 21.56%. Ore microscopy study reveald that the ore mineral found in Palavalasa zone is mainly psilomelane and pyrolusite.

During G4 stage reconnaissance survey for manganese mineralisation in Garbham area of eastern ghat mobile belt in Srikakulam and Vizianagaram district, Large-Scale Mapping of 100.0 sq. km was carried out. Two prospective manganese zones were recognised viz. Gottipalli-Sivannadoravalasa manganese zone or Zone-I and Garbham-Budharayavalasa Manganese Zone or Zone-II. In Zone -I, out of five trenches, Mn mineralisation was found in three trenches with the highest value of 5.79% MnO. Analytical results of bedrock sample gave MnO value ranging from 0.12 to 21.52%. Iron content (14.45 to 29.68%) was more than that of MnO content. The Mn minerals observed are pyrolusite and psilomelane. Six trenches and four pits in Zone-II, did not intersect mineralised zone. The MnO values in bedrock samples were found ranging from 0.01% to 48.50%. Based on analytical results and ground geological set up, an area of 3.0 sq. km area was identified in Garbham-Budharayavalasa zone for further study.

In Srikakulam district, G4 stage reconnaissance survey for manganese mineralisation was taken up in Pallavalasa area of eastern ghat mobile belt. Large-Scale Mapping of 100.0 sq. km area on 1:12,500 scale was carried out in the study area. The surface manifestation of encrustation and botryoidal precipitation of manganese have been recorded in Pallavalasa and Pidi-Mandasa areas. Manganese ore minerals in the Pallavalasa area were pyrolusite and psilomelane. The MnO values ranged from 0.02% to 9.09%.

In Vizianagaram district, a G3 level preliminary exploration for manganese in Solipikonda-Gumpamkonda block, part of eastern ghat mobile belt involved detailed mapping of 1.5 sq. km area and a cumulative drilling of 264.3 m in 4 boreholes along with pitting and trenching. A 900.0 m long and 20.0 – 30.0 m wide manganese zone was established in Gumpamkonda block. In Solipikonda block, the mineralized zone was established to a strike length of 450.0 m.

In Jharkhand, a G3 level preliminary exploration for manganese mineralization was carried out around Sasandih-Jilindungri area, Saraikela-Kharsawan and East Singhbhum districts. Detailed mapping covering 5.0 sq km area on 1:4000 scale was carried out in the study area. Two manganiferous bands composed of alternate bands of tuff and quartzite were demarcated on northern and southern limb. The width of the

northern limb of manganiferous horizon varies from 25.0 m in the central part to 78.0 m in the north-western part of the study area with average width of about 52.0 m. In the southern limb, the width varies from 15.0 m in the central part to 115.0 m in the north-western part of the study area with average width of 65.0 m. The northern band and southern band has strike length of 1100.0 m and 1500.0 -1800.0 m, respectively. A cumulative 378.50 m drilling in 11 boreholes was completed with spacing of 300.0 m in the northern and southern band. The depth of mineralized zone reported in different bore holes vary from 0.40 m and 9.0 m. MnO content of manganiferous bands vary between 11.13% and 21.15%. The samples taken from the trenches in the eastern and central part of northern band analyzed MnO 7.39% and 16.58%, respectively. The samples from southern band yield MnO content between 1.64% and 17.11 %. Seven channel samples taken from the southern band contain MnO above 10%. During G4 stage reconnaissance survey for manganese ore in east of Jhirpani and Amgobha, Sundargarh district, Odisha and Simdega district, Jharkhand, an area of 100.0 sq km was mapped on 1:12,500 scale. Gondite bodies with small manganese bands occur discontinuously as clusters around (i) between Raidhi and in East of Jhirpani, (ii) Jhirpani and (iii) Amgobha areas for a length of about 50.0 m to 200.0 m. Thickness of Mn ore bands is about 2 to 3 m. Pyrolusite and psilomelane are common minerals reported in the area. Pockets of Iron ore were also mapped, of which the one is near Kahapani-Amgobha area extent for a strike length of about 900.0 m with width of about 5 – 25 m.

In Karnataka, a G4 stage reconnaissance survey for Manganese, iron ore and associated cobalt mineralization in parts of Hittala and Gilalagundi area, Shimoga district involved large scale mapping of 100.0 sq km on 1:12,500 scale. A total of eight manganese mineralized zones / bands was identified in the area. Most of the bands were lensoidal and in small pockets lacking appreciable length and width except two bands which have shown appreciable length and width. Low grade iron ore zone with average 33% Fe content for 7.5 m width and a low grade cobalt zone with 207 ppm average grade of Co for 2 m width were identified. Petrochemical sample (PCS) has shown the assay value of MnO 25.80 to 27.27%. In Haveri and Davangere districts, a G4 stage reconnaissance survey for manganese, iron ore, associated Cobalt and polymetallic mineralization in Chikka Gonageri area involved mapping of 100.0 sq km on 1:12,500 scale. Two thin mineralized BIF bands were demarcated on the eastern side of Chikkagonageri village and 6 discontinuous bands of BIF were observed in the Madenahalli reserved forest. The Band III and IV of Madenahalli reserved forest has surficial indications of manganese and iron ores in the form of pyrolusite and goethite. The visual estimation of grab samples indicated low to medium grade of manganese and iron. In Chikkagonageri area, Band I and II extend for a strike length of 300.0 m with 30.0 m width showed Mn value ranging from 2.41% to 13.10%, Fe - 15.4% to 33.6%, Pb - 0.1% to 0.6% and Zn - 0.1% to 0.31% in the BRS samples. In Haveri district, a G4 stage reconnaissance survey for manganese and low grade iron ore with associated cobalt mineralization in ferruginous and manganiferous lithounits and associated rocks in Masur- Kanvi Siddageri area comprised large scale mapping of 100.0 sq km area on 1: 12,500 scale. Analytical result of BIF has yielded Cu values from 220-550 ppm and Zn values from 210 to 540 ppm. Ni enrichment was noticed only in ultramafics (talc schist) with values of 1350 and 1660 ppm. Cr enrichment was observed especially in ultramafics with values ranging from 1620 to 4509 ppm in 06 samples. Only one sample of BIF and Fe phyllite showed Cr values of 1620 and 2325 ppm, respectively. Quartz vein within meta-basalt showed Co and Mn values of 320 ppm and 7.6%, respectively. The maximum value of Fe is 36.6% with an average of 13.01% from both BIF as well as Fe phyllite. In Uttar Kannada district, a G4 stage reconnaissance survey for manganese, iron ore and associated cobalt mineralisation in Devanmane and Gumlagadde areas, Ankola, Kumta and Sirsi taluks, involved large scale mapping of 100.0 sq km on 1:12,500 scale. The Mn mineralization occurs mainly in the form of pyrolusite and massive in nature. At many places, powdery aggregate of Mn rich mineralization was also noticed. On the basis of geochemical results, 31 samples have shown high values ranging from 24.122% to 61.544% Fe, 56 samples have shown anomalous values ranging from 0.27% to 50.66% Mn and 5 samples have shown high Co values ranging from 80 to 110 ppm.

In Madhya Pradesh, during G4 stage reconnaissance survey for manganese mineralisation in Vav-Ringola-MotaKutaja-Bhabra area in Alirajpur

district, an area of 100.0 sq km was mapped on 1:12500 scale. A new occurrence of high grade manganese was noticed in a dump material of a well section near Kansat. The new find of manganese in Kansat is encouraging because of high value of Mn (36.64%) and appears to be the subsurface extension in SE direction of the known near surface old pit of manganese in Vav area which gave 13.69 % Mn in bedrock sample. Both locations of manganese are aerially 6 km apart and falling well within the regional trend of NNW-SSE. It is speculated that Kansat area may show extensions of Mn bearing lenses/bands of high grade. In Khargone district, a G4 stage reconnaissance survey for manganese mineralization in Nandiya-Agarwara- Narsinghpur-Jethwai area covered large scale mapping of 52.0 sq km area on 1:12,500 scale and detailed mapping of 4.5 sq km area on 1:4,000 scale alon with geophysical survey of about 32 L km area in the Agarwara-Nandiya area. Surface evidence of manganese mineralization has been found mainly in and around Agarwara and Nandiya areas. The chemical analysis results of 22 nos. of spot BRS samples collected from old workings showed promising MnO values. Chemical analysis of two channel samples showed 10.6% & 14.9% MnO and 7.6% and 1.6% MnO. Eight BRS samples collected from the old workings showed values of MnO above 10% with a maximum value of 32.98% MnO.

In Odisha, a G4 stage reconnaissance survey for manganese ore in Mandhara block, Rayagada district involved detailed mapping on 1:2000 scale and collection of 50 bed rock samples, 42 samples from pitting and trenching of 90 cu. m area. There are two major manganese bands and three minor manganese bands recorded in the study area. The cumulative length of the major bands - I and II is 700.0 & 450.0 m with width varies from 1.0 to 16.0 m & 2.0 m to 25.0 m, respectively. The chemical analysis results of 25 trench samples collected from 4 trenches manganese 0.42% to 24.42% with a weighted showed average of 14.19% Mn.

A G4 stage reconnaissance survey was taken up for manganese ore in Devjholla block, Koraput district comprised detailed mapping of 0.96 sq km area on 1:2000 scale. Manganese ore i.e. pyrolusite & psilomelane in area is lenticular in shape and discontinuous in nature. Four distinct manganese ore zones were mapped to a cumulative strike length of about 400 m. Zone-1 has cumulative strike length of 244 m with avg. width of 16 m; Zone-2 has strike length of 35 m with average width of about 5 m; Zone-3 has strike length of 83 m with average width of 12 m and Zone-4 has strike length of 28 m with average width of about 5 m. A total of 115 nos. of samples from bedrock and trenches have been sent for chemical analysis and results of the 19 BRS sample were received which showed Mn content varying from 8.61% to 30.97%.

In Kalahandi district, a reconnaissance survey for manganese was taken up in Taprang block. An area of 1.0 sq km was mapped on 1: 2000 scale along with gravity and magnetic survey to delineate manganiferous bands. Manganese ore bearing horizons were delineated in two localities in the Taprang block. One 150.0 m long, thin band of manganese ore was mapped in the northern part of hill top. In the southern part, manganese ore body is discontinuous in nature. The major manganese ore minerals of the area are pyrolusite, manganite, psilomelane- cryptomelane and braunite. Goethite and graphite occurs at places. In bed rock samples, the MnO value ranges from 0.03% to 14.04%. In PCS the MnO value ranges from 0.01% to 18.09. In PTS, MnO value ranges from 0.08% to 22.52%.

Directorate of Geology and Mining, Maharashtra

During 2019-20, exploration for manganese ore was carried out in Nagpur districts. Objective was to delineate the manganese deposit & to calculate the reserves/resources of manganese ore.

In Nagpur district at Tangla - Salai-Ghoti-Chachada block, Ramtek tehsil, an area of 102.82 sq km was mapped on 1:25,000 scale & 11.63 sq km area on 1:5000 scale. In all total 15 samples were collected from two trenches each admeasuring10 m x 4 m x 2 m. Area has been proposed for further exploration in field season 2020-2021.

Department of Mines & Geology, Andhra Pradesh

In Vizinagaram district, G3 level exploration was carried out in Sadanandapuram village, Gurla mandal and Chinnabantupalli village, Merakamudim mandal covering an area of 36 hect and 45 hect respectively by geological mapping, gravity and magnetic surveys. In Sadanandapuram area, 10 boreholes were drilled to a depth of 677.00 m

whereas in Chinnabantupalli area, 12 boreholes were drilled to a depth of 831.00 m. The sampling in both areas are in progress. Reconnaissance survey for manganese was taken up in villages of Batuva, Mandiravalasa (Garividi mandal), Nimmalavalasa (Cheepurupalli Mandal) and Peddalingalavasala (Laveru Mandal) and magnetic and gravity survey covered 243 hect, 300 hect, 445 hect and 472 hects, respectively. In Batuva area, 243 hect was covered by magnetic and gravity survey and 8 boreholes drilled to a depth of 542 m; in Mandiravalasa area, 300 hect was covered by magnetic and gravity survey and 8 boreholes drilled to a depth of 540 m; in Nimmalavalasa area, 445 hect was covered by magnetic and gravity survey and 10 boreholes drilled to a depth of 309 m; in Peddalingalavasala area, 472 hect was covered by magnetic and gravity survey.

Directorate of Geology, Odisha

In Odisha, a exploration in Roida-D area, Keonjhar district was carried out with the objectives to assess manganese ore resources with its grade. Two irregular sporadic outcrops were delineated. The manganese exposure at the central part has the maximum length of 10 m and average wodth of 4 m. The cumulative thickness of ore body encountered in boreholes is about 47.55 m. The study involved drilling of 10 boreholes, at grid spacing of 100 m x 50 m, to a total depth of 354 m and collection of 143 samples. Exploration is continuing the area. In Tentuliguda area, Keonjhar district, exploration was taken up to assess manganese ore resources in the area. One manganese ore body admeasuring 15 m x 30 m has been located at west of Bagchuan village. The study involved geological mapping of 121 sq.km area on 1:12,500 scale and collection of 37 samples. Exploration suspended due to local problems in the area.

MECL

In Odisha, a G2 stage exploration in Tamiya village, Patangarh tehsil, Bolangir district was carried out with the broad objectives to carry out detailed geological mapping and estimate indicated category resources of manganese ore in the area. The study involved mapping of 8.05 sq.km area on 1:4,000 scale with collection of about 893 samples along with a trenching and 5 pittings of dimension 1m x 1m x 1m. Resources in the area has been estimated at about 633 thousand tonnes of manganese ore with 23.04% Mn under indicated category. A G2 stage exploration was carried out over an area of 1.831 sq.km in Rengali block, tehsil & district of Bolangir with the broad objectives to carry out detailed geological mapping and estimate indicated category resources of manganese ore in the area.The study involved mapping of 1.83 sq.km area on 1:12,500 scale with collection of different types of 1,556 samples along with a trenching and 5 nos of pittings admeasuring 1m x 1m x 1m. Resources in the area has been estimated at 328 thousand tonnes of manganese ore with 21.37% Mn, 15.82% Fe and 0.28% P under indicated category.

In Madhya Pradesh, a a G4 stage exploration in Udwara area, Alirajpur district was carried out with the broad objectives to carry out geological mapping, collect and analyse different types of samples,scout drilling in potential areas and estimate reconnaissance category resources of manganese ore, graphite and phosphorus alongwith accessory minerals in the study area. The study involved mapping of 221.49 sq.km area on 1:12,500 scale, drilling of 2 scout boreholes to a depth of 240.60 m with collection of about 1714 samples including 250 pit/trench samples, 60 channel samples and 419 stream sediments samples. Resources in the area has not been estimated.

MOIL

During 2019-20, a total of 7,307.5 m exploratory drilling involving 72 boreholes in 10 manganese ore mines were carried out. Among these 10 mines, two mines viz, Dongri Buzurg & Chikla manganese mines are situated in district Bhandara. Retain, Kandri, Mansar, Gumgaon, Parsoda and Old Satuk mines are situated in district Nagpur, Maharashtra State; Two mines viz, Tirodi and Bharweli mines are situated in district Balaghat, Madhya Pradesh. The reported reserves/resources of manganese ore as on 1.4.2020 of all the 13 mines of MOIL were estimated at 90.20 million tonnes. Ukwa (13.71 million tonnes), Bharweli (24.60 million tonnes), Tirodi (0.68 million tonnes), Sitapatore & Sukli (0.11 million tonnes & 0.14 million tonnes), Chikla

(4.62 million tonnes), Dongri Buzurg (18.46 million tonnes), Kandri (12.04 million tonnes), Mansar (5.55 million tonnes), Parsoda (0.49 million tonnes), Beldongri (0.13 million tonnes), Old Satuk (0.49 million tonnes), New Satuk (0.22 million tonnes) and Gumgaon (8.95 million tonnes).

Rare-Earths Elements (REE)

GSI

In Arunachal Pradesh, a G3 level preliminary exploration for REE and associated precious and basemetal in Lodoso East block, Papum Pare district comprised detail mapping of 1.0 sq km area on 1:2000 scales with 1000.0 m of drilling, 100.0 cu. m of pitting/ trenching and collection of 100 samples for EMPA analysis to evaluate the occurrences and potential of REE and associated basemetal mineralization in the area. Gossanous zone was the first indication of major mineralized body present in forest areas of the block. The particular mineralized zone is about 1000 m in strike length with outcrop thickness of about 30 m to 40 m was noticed in the study area. Dendritic shaped native copper, magnetite, brochantite and pyrite were some of the minerals recorded in the zone of interest. The samples collected from the mineralized zone yielded maximum 3% tREE in channel sample, 4808 ppm value of tREE with avg. of about 2385 ppm from trench sample, Cu value of 1620 ppm, Au value of 120 ppb from spot samples.

In Assam, G4 stage Reconnaissance survey for REE, V and associated minerals in phosphate bearing shales of Kopili Formation in Boro Hundong area, Dima Hasao district involved large scale mapping of 50.0 sq km area on 1:12,500 scale and 102.0 cu m of pitting and trenching. Phosphatic nodules are few millimeters to twelve centimeters in diameter. The thickness of band containing the phosphatic nodules is 1.0 to 1.5 meters with an average concentration of 0.3% phosphatic nodules per unit volume of shale. Chemical results showed P_2O_5 value ranging from 0.07% to 5.05% with highest values observed in phosphatic nodules of Kopili Formation collected from Bodo Hundong village. The highest value of total REE from the phosphatic nodules is 1233 ppm recorded near Cheksolangso village and the lowest value is 121 ppm reported from grey shale. The Vanadium value 681 ppm recorded from black shale exposed near Lobang village and lowest value is 145 ppm recorded from grey shale.

During G4 stage reconnaissance survey for REE and associated mineralization in and around Byrnihat area, Ri-Bhoi district, Meghalaya and Kamrup (Metro) district, Assam, large scale mapping of 50.0 sq km area on 1:12,500 scale, collection of various types of 200 samples along with 5.00 cu m pitting /trenching and 398 m drilling in 15 nos. of boreholes carried out in the study area. Chemical analysis results showed 0.24% Ba, 0.14% Cr, and 0.1% Sr. REE were reported 1064 ppm within diorite of Umprikhola. Zinc value of 445 ppm was recorded from sulphide bearing cordierite metapelite of Tandu area. Yttrium value of 2098 ppm was reported in pink granite intruded within cordierite metapelite of Umdot area.

In Maharashtra, a G4 stage reconnaissance survey for locating Rare Metal (RM) & Rare Earth Elements (REE) mineralization in granite and associated pgmatitic veins of Sausar mobile belt around Ronga-Lendejhari area, Nagpur district was taken up. An area of 100.0 sq km was mapped on 1:12,500 scale. Pegmatites at the contact of basic rocks have apatites and monazites in large quantity. The bed rock samples collected from the outcrop have shown ?REE values of up to 784.85 ppm. Heavy segregation from 2nd order streams sediments have REE values ranging from 303.24 to 119695 ppm. Values in soil samples ranging from 217.05 to 3681.37 ppm. Monazite, zircon, apatite phases were identified under the microscope. Presence of zoned tourmaline suggests multiple phases of fluid intrusion. Xenotime, uraninite, monazite, zircon, apatite phases were also identified.

In Madhya Pradesh, during G4 stage reconnaissance survey for REE & associated mineralization in Rojhwa-Bari Sadri-Ambua- Bana-Khandala- Panidungla area, Alirajpur district, an area of 100.0 sq km was mapped on 1:12,500 scale. Bed rock samples of aplitic phase in porphyritic granite has given relatively higher concentration of ?REE about (~)2263.89 ppm. Petrological study has revealed the presence of allanite, titanite, apatite and zircon which may have contributed towards the relative high concentration of total REE in the rock. The porphyritic granite in which these aplitic phases are present showed moderate REE ~1500 ppm. The aplitic phases occur as bands of 2 cm to 50-80 cm in width. Such aplitic phases were also observed near Sadli, Mota Rampur and Dongargaon villages. Further chemical results are awaited to know the potentiality of REE in these granites.

A G4 stage reconnaissance survey was taken up for locating RM & REE mineralization in granite and associated pegmatitic veins of sausar mobile belt, Ashti - Kanhargaon area in Bhandara district, Maharashtra and Balaghat district, Madhya Pradesh. The study involved large scale mapping on 1:12500 scale, pitting/ trenching and sampling.

A total of 17 pegmatite bodies were mapped and studied in detail. Pegmatite was noticed in SW of Ramjitola village, along Dhoriya Nala. Analytical result showed very high concentration SREE in stream sediments samples collected from pegmatite terrain with maximum value SREE 23.63%. Pitting and trenching samples and soil samples collected from pegmatite terrain also showed moderate to high concentration of SREE. Maximum concentration observed in Pitting and trenching sample is SREE 2.1% and concentration observed in soil sample is SREE 3146.78 ppm. LREE concentration is much higher in comparison to HREE concentration. Bed rock samples of foliated granite showed maximum value SREE 1276.1 ppm and soil sample showed maximum value SREE 1767.49 ppm. Maximum concentration of zirconium 2977 ppm is observed in soil sample collected from pegmatite terrain.

In Chhatarpur District, during G4 stage reconnaissance survey for Rare Metal (Zr-Y-Nb), REE and associated mineralization in Barkaun-Sandni area, large-scale mapping of 100.0 sq km area on 1:12,500 scale was carried out. The K-rich granitoids have manifested some favourable surface indications of mineralisation in the form of pyrite, chalcopyrite, pyrrhotite, arsenopyrite, molybdenite, etc. RM (Zr, Y, Nb) and REEs are hosted within REE-bearing minerals which are associated with alkali feldspar granites. The zone of intersection between different joint sets are important locales for concentration of mineralization.

In West Bengal, a G4 stage reconnaissance survey for Rare Metal in pegmatite and aplite bodies of around Khatanga area, Purulia district was taken up. A total of 0. 2 sq km detailed mapping at 1:2000 scale was carried out. The area comprises mainly three litho units viz. granite gneiss, calc-silicate rock and pegmatite. Chemical analytical data showed anomalous cesium (40 to 207 ppm) and rubidium (1000 to 2578 ppm) values and the maximum value came from amazonite.

During G4 stage reconnaissance survey for REE and associated mineralization in the Kuilapal Granite and associated rocks in West Medinipur, Bankura and Purulia districts, an area of 100.0 sq km was mapped on 1: 12,500 scale. The litho units in the study area are mainly Kuilapal Granite Gneiss (KGG) and metapelitic rocks of Singhbhum. Calc-silicate rocks also occur as enclave within KGG near, Jhilimili, Kanthaliya and Bostampur areas. Hydrothermal alteration zone in south-eastern margin of KGG near Raja Pahar and alteration zone in Madhabpur were studied thoroughly for REE and for base metals. Microscopic studies revealed that presence of allanite and few radioactive minerals in the areas.

In Bihar during G4 stage reconnaissance survey for REE and RM around Gobardaha, Hathiyapathar, Suiabatahan, Jeruapahari, Dhanauchi and Tindobha area in Banka district, large scale mapping of 100.0 sq km area was carried out on 1:12,500 scale in the area. The REE bearing minerals were reported in the medium grained granites (allanite) intruded within the porphyritic gneiss around Tangeshwar village and also the migmatite gneiss exposed around Amtua, Dhanauchi and Dhawana villages. The REE bearing heavies i.e. allanite, monazite, apatite, xenotime and fluorite were identified in stream sediment samples.

A G3 level preliminary exploration for REE and RM in Heth Chandan block, Banka district involved detailed geological mapping of 2.0 sq km on 1:2,000 scale, 300.0 m auger drilling, 50 cu. m pitting/trenching and collection of 470 samples. Younger granite bands within granite gneiss are the most potential lithological units for REE mineralization in the area. Few pegmatite/quartz veins were injected within country rock i.e., granite gneiss. The heavy mineral studied under microscope revealed the presence of REE bearing minerals like allanite, monazite and xenotime with other heavy minerals i.e. magnetite, ilmenite, zircon, tourmaline etc.

During G3 level preliminary exploration for REE and Rare Metals in Dhawa block, Banka district, detailed geological mapping of 1.5 sq km on 1:2,000 scale, auger drilling of 300.0 m and pitting/trenching of 50.0 cu m was carried out in the area. A total 485 geochemical samples were also collected from the study area for chemical analysis. The heavy mineral microscope study revealed the presence of REE bearing minerals like allanite, monazite and xenotime with other heavy minerals viz. magnetite, ilmenite, zircon, tourmaline etc

A G4 stage reconnaissance survey for REE and Rare Metals was taken up in and around Batesharthan, Kasri and SE of Pirpainti parts of Bhagalpur district, Bihar and Godda district, Jharkhand. An area of 104 sq km was mapped on 1:12,500 scale of the study area in four blocks viz .Block-I covering an area of 59 sq km, Block-II covering an area of 35 sq km, Block-III covering an area of 06 sq km and Block-IV covering an area of 04 sq km. The analytical results of 57 nos. of bedrock samples showed SREE ranges from 24.00 to 781 ppm in granitic gneiss samples and SREE content in rocks of Dubrajpur Formation ranges from 92 ppm to 435 ppm.

In Jharkhand, reconnaissance survey for strategic, REE, RM and base metal was carried out in Chhotanagpur gneissic complex in and around Bara Changru-Banta Hajan-Dulmi areas, Ranchi district. An area of 100.0 sq km was mapped on a scale of 1:12,500 during survey. About 77 pegmatites was recorded in the area. Surface manifestation of REE mineralization was found to be occuring in the form of allanites. Four mineralized zones were identified in the area. To know the mineral potentiality in the study area, a total of 27 trenches with a dimension of 1 m width x 1 m depth of variable length were dug across the strike of pegmatites. The tREE values obtained from 10 petrochemical samples give a maximum of 368 ppm whereas the tREE values obtained from 20 bed rock samples give a maximum of 1700 ppm. Some BRS samples have tREE values of >1000 ppm falls within demarcated zones I and IV of the study area.

During G4 stage reconnaissance survey for REE and Rare Metals in Bihar Mica Belt within Chhotanagpur Gneissic Complex, Deoghar district, large Scale Mapping (LSM) of 100 km2 area on 1:12,500 was carried out. In granite gneiss, two generations of pegmatites are noted: one rich in plagioclase and other rich in orthoclase. In this belt, pegmatite is known as the host for columbite-tantalite, REE minerals and beryl. No surface indication for REE is seen, however, the presence of heavies like alanite, xenotime, tourmaline and ilmenite and suspected columbite-tantalite are noticed. In the north of Tulsitanr, surface indication of base metal is noticed in form of staining of malachite, azurite and galena. Different types of rock and sediment samples have been taken from the study sites to further understand the mineralisation potential.

A G4 stage reconnaissance survey for REE and Rare Metals was taken up in Bihar mica belt and Chhotanagpur gneissic complex in and around Dhab area, parts of Giridih and Koderma districts, Jharkhand. An area of 100.0 sq km area was mapped on 1:12500 scale. A total 60 nos. of BRS, 50 nos. of stream sediment sample and 60 nos. of pitting trenching samples analysed for trace element and rare earth elements show higher values of Zr (101-3046 ppm), Y (21-300 ppm), Sc (7-33 ppm) in stream sediment samples whereas, Rb, Sr, TiO_2 values are relatively higher in BRS and pitting samples. A total of 13 bed rock samples and 17 stream sediment samples showed tREE values above 1000 ppm. Stream sediment sample no. 63 is having REE+Sc+Y value of 11,248 ppm (1.1248%). Sample no. BRS-137 has anomalous value 23.80% of Nb, which confirms presence of columbite in the pegmatite near Kabraboot village of the study area.

In Bihar Mica Belt (BMB), some of the pegamtites are zoned pegmatites, which are potential for rare earth elements and rare metals. Some zoned pegamtites were identified in the study area in which columbite tantalite noticed. Beryl, columbite, tantalite, uranium minerals, lithium, Cesium and rubidium elements were reported in the study area. BMB could be very vital area for REE and RM in future. Lithium bearing pegmatites reported in Charkhi-Manimahadar-Pihra zone, Gawan-Tisri zone and Bijaia-Asarhua-Lamki zones of BMB.

In Jharkhand, a G4 stage reconnaissance survey for REE, RM and other strategic minerals in Chhotanagpur Gneissic Complex in and around Dumartoli-Halhu-Jalalong areas, Ranchi district comprised mapping in 100.0 sq km area on 1:12,500 scale. An east-west trending gossan zone was identified in west of Jaratoli village. The length and width of this gossan zone is around 6 km and 500 meter, respectively. The analytical result of gossan samples revealed encouraging value of gold (0.16 ppm), silver (up to 17 ppm), copper (up to 6800 ppm), lead (up to 4800 ppm) and zinc (up to 4660 ppm). In the west ward extension of this gossan zone, north of Harmu village, good

concentration of galena (lead) and sphalerite (zinc) were reported. A mica schist band of length and width around 12 km and 400 m, respectively was mapped in south of Sarambel where a zone of width around 100.0 m containing molybdenite (MoS_2). Analytical results from this zone indicated molybdenum value up to 10.6 ppm.

In Ranchi district, during G4 stage reconnaissance survey for REE, RM, barite and base metal minerals in Chhotanagpur Gneissic Complex in and around Hesal-Sisipidih-Tiskilitoli areas, an area of 100.0 sq km was mapped on 1:12,500 scale. Probable mineral phases like Monazite, Xenotime were identified in heavy mineral separated from stream sediments collected near Jamchua village in southern part of the exploration block. The other mineral phases presumed columbite and tantalite in magnetite rich pegmatites near Badritoli village. Pegmatites in south western part of the exploration block may be probable source of REE mineralization. Analytical results revealed more than 1000 ppm total REE concentration in 9 samples. Samples collected near Lupung village showed a total REE value of 1036.60 ppm to 1796.76 ppm. Samples collected from regolith near Dhilwakhuta and Tungritoli contain total REE 1230.02 ppm - 1245.38 ppm. Stream sediment sample taken from second order stream near Bartoli village showed tREE value of 1333.14 ppm. One PTS collected near Bhuwatoli village showed La content of 1283.58 ppm, Ce 3104.6 ppm, Ba 25.15%, Pb 5120 ppm and tREE 5560.50 ppm. Barium (Ba) content of 5.58% was recorded near village Buchhatoli .

A G4 stage reconnaissance survey for REE and Rare Metals was taken up in Bihar Mica Belt and Chhotanagpur Gneissic Complex around Kharkhari area in parts of Giridih and Koderma districts. An area of 100 sq km of aerial reconnaissance studies and geological survey were carried out on 1:12500 scale in the study area. Four samples collected near East of Doranda village have yielded high value for Cerium i.e. more than 1000 ppm. The columbite-Tantalite mineralization is associated with pegmatite veins observed near the Kharkhari, Satidih and Gadi Khurd villages of the study area.

In Meghalaya, G4 stage reconnaissance survey for REE and other associated minerals in parts of East Khasi Hills, West Khasi Hills & Ribhoi districts was taken up to assess the REE and other associated minerals in the study area. The survey comprised regolith mapping, section measurement and collection of different types of samples. The analytical results indicated total REE in bedrock samples of Wallang -Nongspung area ranging from 339.21 to 1224.79 ppm (excluding Sc and Y) with an average of 651.83 ppm. In the C-horizon of soil, the TREE value ranges from 1525.92 to 3572.77 ppm (excluding Sc and Y) with an average of 2763.18 ppm and in B-horizon it varies from 482.62 to 2553.47 ppm (excluding Sc and Y) with an average 1609.94 ppm.

In Uttar Pradesh, a G4 stage reconnaissance survey for REE-RM mineralization was taken up in Mahuaria-Domardiha area, Sonbhadra district. Results of the 04 soil samples used in orientation survey yielded an average ?REE value of 343 ppm and 350 ppm for -80 and -100 fractions, respectively with average ?REE value for -120 fractions was 271 ppm. Analytical results of 9 bedrock samples yielded ?REE values >800 ppm. The highest value was recorded from a micaceous schist hosted by K-feldspar granite gneiss from Rannu area. A leucogranite body with ?REE of 1475 ppm exhibited good enrichment in HREEs. Besides this, high values were observed from K-feldspar granite gneisses.

A G3 level preliminary exploration for REE mineralization in Nawatola - Laband area, Sonbhadra district involved drilling of 500.85 m, pitting/ trenching of 84 cu m and collection of 50 channel samples, 83 pit-trench samples and 50 soil samples. A total of 6 scout boreholes were drilled based on the channel/trench samples with REE >900 ppm. Strike length of enriched REE zone is 1.5 km with an average width of 400m. This zone is demarcated based on relatively higher concentration of REE in surface samples i.e. 500 ppm. Also, maximum REE concentration in soil sample yield up to 2729 ppm. In borehole-1, weighted average grade of REE+Y was recorded 1065.69 ppm for a total thickness of 23.50 m. In borehole-2, weighted average grade of REE was recorded 992.2 ppm for total thickness of 10.50 m and in borehole-3, weighted average grade of REE varied from 973.5 to 1272.8 ppm with weighted average 1064.9 ppm for total thickness of 13.50 m.

In Uttarakhand, during G4 stage reconnaissance survey for REE, Sn, W, Mo, Rare Metals mineralization in Gangotri granite, Uttarkashi district, a traverse mapping was carried out for 85-line km on 1:25,000 scale. Two potential mineral blocks were identified i.e. first block is Nelong-Naga-Jadhang-Nilapani block which host pyrite, chalcopyrite, galena with molybdenite flakes and second block is Harsil-Mukhaba-Jhala block which defines occurrence of highly fertile rare metal pegmatite complex. Both parent granite and pegmatites contain rare metal minerals i.e. beryl, cassiterite, ferrocolumbite and ferrotapiolite.

In Haryana, a G4 stage reconnaissance survey for REE, RM in Bayal Pegmatite, Mahendragarh district involved large scale mapping of 25.0 sq km on 1:12500 scale followed by 1.0 sq km of detailed mapping on 1:1000 scale. The major pegmatite body was measured for 3 km strike length with 650 to 700 m in width Based on the chemical analysis received, the total REE values in samples ranges from 13.18 to 746.36 ppm. The highest total REE value of 746.36 ppm was reported in BRS-4 followed by 593.35 ppm in BRS-5 samples collected from pegmatite exposed to south of Panchnota village. The highest Li value of 41.93 ppm and Cs value of 8.99 ppm was reported in samples collected from pegmatite near Bayal village. In pitting/trenching samples, total REE value ranges from 62.79 to 798 ppm.

In Telangana, a G4 stage reconnaissance survey for REE and Rare Metal (RM) mineralization was taken up in granitoids and migmatites of Peninsular Gneissic Complex around Kondur and Chintapalli areas in parts of Nalgonda district. Sporadic occurrences of allanite and fluorite rich pockets were reported towards the northern part of the area within both discontinuous pegmatites and host alkali-feldspar granites. Preliminary results indicated very few localized high REE values up to 12740 ppm in pegmatite towards the north-eastern part of the study area.

In Rangareddy and Nalgonda districts, a G4 stage reconnaissance survey for REE and RM mineralization was taken up in and around Kothapalli and Murtuzapalli area. The total REE values in samples from bedrock, stream sediment, pitting-trenching and soil regolith ranges from 20 to 749 ppm, 251 to 590 ppm, 92 to 910 ppm and 197 to 1071 ppm, respectively. Higher values of REE in bedrock samples were generally recorded in sheared granite.

A G4 stage Reconnaissance survey for REE and RM mineralization in granitoids of Peninsular Gneissic Complex was taken up around Polepalli and Timmapuram areas in Nalgonda District. Large scale mapping on 1: 12500 scale was carried out in the area. REE and RM mineralization is mainly confined to pegmatite veins. Allanite is an indicator mineral for REE, noticed in pegmatite vein intruded in alkali feldspar and plagioclase rich granite. Chemical analysis obtained so far showed TREE values up to 963 ppm.

During G4 stage survey for REE and RM mineralization in parts of the Kunnavaram Alkaline Complex, Bhadradri-Kothagudem district, bed rock samples, stream sediments, soil, pitting and trenching samples were collected for analysis. Chemical analysis of hornblende nepheline syenite reported total REE content varies from 1000 ppm to 1100 ppm.

In Karnataka, a G3 level preliminary exploration for Rare Earth Element (REE) mineralization in regolith zones over pyroxenite and syenite rocks, near Budihalu, Koppal district involved detailed mapping of 7 sq km area on 1:4000 scale in the study area. TREE value in the -200 fractions of regolith samples developed over phoscorite, syenite and gneiss varies from 287.8 to 5153.95 ppm, 406.4 ppm to 1241.3 ppm and 463.8 ppm, respectively. High value of TREE was noticed in phoscorite which are rich in apatite content. Bedrock samples of phoscorite showed TREE values ranging from 796 to 8019 ppm.

During G4 stage reconnaissance survey for REE mineralization in granitoids of Jamapanayakanakote – Sondekere block, Chitradurga district, an area of 100.0 sq km was mapped. Neither REE mineralization in study area was reported nor any encouraging value obtained in the available analytical results. However, significant occurrence of gold (97 to 14200 ppb), copper (field observation; specs of azurite, bornite, malachite) and molybdenum (65 to 370 ppm) mineralization were noticed in hydrothermal alteration zone.

In Tamil Nadu, a G3 level preliminary exploration was carried out for Rare Metals and REE in carbonatite of Koratti Syenitic Complex,

Vellore district. The study involved detailed mapping of 2.0 sq km area on 1:2000 scale, 1000.0 m drilling and pitting & trenching of 100 cu m. The surface samples (82 BRS samples) and 20 PTS collected in a borehole showed REE values ranging from 533 ppm to 2849 ppm with an average value of 1287 ppm. HREE varies from 77 to 127 ppm. Besides REE, anomalous values for Ba and Sr were also noticed in the area. Ba ranges from 967 to 2340 ppm with an average of 1382 ppm whereas Sr is observed to a maximum of 10367 ppm. Apatite rich carbonatite shows the maximum 11% of P_2O_5.

In Theni district, during G4 stage reconnaissance survey for REE and RM mineralization in the carbonatite and associated rocks in Kambammettu-Kambam and adjoining areas, large scale mapping of 100.0 sq km and pitting & trenching of 100 cu m were completed. Three major carbonatite bodies with outcrop width varying from 375 to 900 m and strike length varying between 400 m and 1 km were delineated. Analytical results of 34 carbonatite bed rock samples showed REE values range from 335.98 to 6504.11 ppm with mean value of 2341.49 ppm. In regolith samples, REE (La to Lu) ranges from 436.61 to 1198.53 ppm with mean value of 791.8 ppm. In Kambam area small plugs of pyroxenites were sampled. Of which, two samples have yielded ?REE value of 2029.71 ppm and 1597.53 ppm, respectively. Colluvial samples of two carbonatite in Kambam area have yielded ?REE value of 5075 and 11538.01 ppm. In the bed rock sample, Ba and Sr concentration ranges from 2682.63 to 19830.56 ppm and 3742.88 to 24654.25 ppm, respectively.

In Kerala, G4 stage reconnaissance survey for the possible occurrence of REE and PGE mineralization was taken up in and around Vazhavatta, Wayanad district. An area of 100.0 sq km was mapped on 1:12,500 scale during survey. The available analytical results showed that ?REE values in granite and pegmatite ranges from 15.35 to 662.57 ppm and 15.55 to 166.05 ppm, respectively. Four pegmatite samples from Mandat area analysed Mo value of ranges from 1551 ppm to 2.11% and Cu value 89 ppm to 2820 ppm. Analytical results of samples from two channels in Mandat area showed 2.5 m zone with an average 1149.8 ppm Mo and 2.5 m zone with average 1163.2 ppm Mo, respectively. Talc-tremolite-actinolite schist samples analysed Cr values ranging from 584 ppm to 3742 ppm with an average of 2235.25 ppm and Ni value ranging from 256 to 1435 ppm with an average of 925.75 ppm. Based on the results received, pegmatites within Kalpatta granite at Mandat area is promising for Mo mineralisation and suggested for further study.

In Palakkad and Malappuram districts, large scale mapping of 150.0 sq km was carried out on 1:12,500 scale during G4 stage reconnaissance survey for REE and Rare Metals in Cheruppulasseri area. During field study, it was observed that pegmatite and gneiss (quartzo-feldspathic) are potential lithunits for REE mineralization in the area. Extensive lateritisation process played an important role in release of REE from parent rock. The analytical results of 60 bed rock samples showed that ?REE values in pegmatite, quartzo-feldspathic gneiss and 20 stream sediment samples ranges from 2.88 to 3545.36 ppm, 25.38 to 1383.36 ppm and 390.79 to 2056.48 ppm, respectively.

A G4 stage reconnaissance survey was taken up for REE and Rare Metals in Amayur, Pattambi area, Palakkad district. Large Scale Mapping of 100 sq km area was carried out on 1:12,500 scale. In the eastern part of area near Choorakode village, sheared pegmatite was observed in quartzo-feldspathic gneiss with coarse tourmaline, allanite crystals which seem to be favourable for REE/RM mineralization. The available analytical results showed ?LREE values in pegmatite ranges from 78.29 to 2815.84 ppm with mean value of 498.22 ppm, ?HREE value ranges from 1.86 to 34.79 ppm with mean value of 11.98 ppm and the ?REE values ranges from 80.21 to 2834.01 ppm.

In Kannur district, an area of 100.0 sq km was covered by large scale mapping in Nilgiri block of Southern Granulite Terrain (SGT) during G4 stage reconnaissance survey for REE and Rare metals in Peralimala Syenite. The analytical results of 49 BRS samples showed ?LREE values vary from 8.21 to 2308.47 ppm with an average of 142.67 ppm. The ?HREE values vary from 3.82 to 568.30 ppm with an average of 25.45 ppm. The ?REE values vary from 12.02 to 2876.77 ppm with an average of 168.12 ppm. Only one sample is revealed high total REE 2876.77 ppm (La 1085.22 ppm and Nd 800.84

ppm). Analytical results of 15 stream sediment samples showed ?LREE values vary from 81.39 to 267.65 ppm with an average of 135.26 ppm, ?HREE values vary from 8.92 to 31.58 ppm with an average of 13.93 ppm and ?REE content varies from 90.31 to 283.14 ppm with an average of 149.20 ppm.

In Gujarat, a G4 stage reconnaissance survey was taken up for Rare Earth Elements (REE) and Rare Metals (RM) in Kikawada-Ghelvant Area, Chhota Udepur district. The Godhra granite is REE bearing (monazite, zircon, apatite and allanite), however REE mineralisation is not homogenously distributed in it. Pegmatite and aplite, greisenised and albitised zones in granite, skarn zones, epidote rich allanite bearing granitic pegmatite are the potential host rocks enriched in REE. Encouraging total REE content was analysed from the panned heavy samples from the Jarwa, Ani and Vaswa rivers. The TREE from Jarwa is 142171.55 ppm (14.21 %) along with Yttrium (7622 ppm); from Ani River TREE is 36367.04 - 144943.05 ppm; and from Vaswa river it is129840.82 ppm (12.98%). Besides TREE, 398 ppm and 324 ppm of Niobium were recorded from panned sample of Vaswa and Ani rivers, respectively and suggest the rare metal enrichment in the stream sediments. One of the bedrock samples of garnet-rich quartzo-feldspathic vein, near Malu village also characterised by anomalous Nb (264 ppm).

In Chhota Udepur district, detailed mapping in an area of 3.0 sq km was carried out on 1:2000 scales during G3 level of preliminary exploration for Rare Earth Elements (REE) and Rare Metals (RM) in Manka block of Saidiwasan Carbonatite Complex, Kawant Taluka. Carbonatite breccia were identified and demarcated in northern, eastern, southern and central parts in Manka block of Saidiwasan Carbonatite Complex. The exposed thickness of carbonatite breccia is 25-60 m at southern part of the study area. Chemical analysis of 92 samples showed Niobium (Nb) varies from 193-545 ppm, with average of 379 ppm. Analysis of 33 bed rock samples revealed REE value varies from 3574.41 ppm to 5976.74 ppm, with average of 4650 ppm. Chemical analysis of 59 PTS samples showed REE value from 289.92 to 3442.37 ppm, with average of 2432.4 ppm.

A G4 stage reconnaissance survey was taken up for Rare Earth Elements (REE) and Rare Metals (RM) in Satun-Virpur area, Chhota Udepur district. Apart from the primary REE mineralisation, the area is suitable for secondary type of REE hosted in stream placers and regolith. Out of 13 BRS and 9 PTS chemical analysis data, two BRS and one PTS were analysed more than 1000 ppm total REE. For estimation of secondary REE mineralization, heavy minerals were separated in different fractions by panning and sieving of the stream sediments. The non-magnetic fractions are mainly xenotime, monazite, zircon and apatite.

A G2 level general exploration for Rare Earth Elements (REE) and Rare Metals (RM) in southern Ambadungar block of Ambadungar Carbonatite Complex, Kawant Taluka, Chhota Udepur district involved detailed mapping of 0.3 sq km on 1:1000 scale and a cumulative drilling of 2100.0 m in the study area. During the course of exploration, 980 m drilling, 846 core samples, 07 PCS samples, 06 petrological samples, 06 samples for XRD studies and 06 for EPMA were collected. Analytical results of one of the borehole revealed total REE 0.13% to 1.89% with average of 0.95% and Nb value 45 ppm to 2452 ppm with average of 483 ppm. REE values in another borehole vary from 0.048% to 1.52% with average of 0.53%.

During G3 level preliminary exploration for Rare Earth Elements (REE) and Rare Metals (RM) in Nakhal block of Saidiwasan Carbonatite Complex, Kawant Taluka, detailed geological mapping was carried out in 3.0 sq km area on 1:2000 scale. Chemical analysis (XRF) of 71 bed rock samples showed Niobium (Nb) 139 - 1753 ppm with average of 343 ppm. In pit/trench sample, Niobium (Nb) content varies from 6-2031 ppm, with average of 372 ppm.

A G4 stage reconnaissance survey for Rare Earth Elements (REE) and Rare Metals (RM) was taken up in Kelkuva-Jamli area, Chhota Udepur district. Bedrock samples showed TREE value ranging from 600 to 973 ppm. One PTS sample from weathered grey granite analysed 2258.49 ppm TREE. Nevertheless significant REE mineralization in the area is reported in the form of secondary deposits like eluvium, alluvium and colluviums. The stream sediments from the major drainage

system are characterized by good concentration of heavies i.e. xenotime, monazite, apatite, allanite, garnet, zircon and ilemnorutile. Analytical result of 10 stream sediment samples, where grey granite and pegmatites are present in the upper catchment of these streams, analysed 570 to 2070 ppm TREE. Regolith/ talus/ scree/ soil (RS) samples developed over grey granite and weathered pegmatite reported encouraging TREE value ranging from 725 ppm to 2096 ppm. On the basis of partially available data, the area seems to host REE bearing rocks and potential for secondary-type REE mineralization.

In Rajasthan, during G4 stage reconnaissance survey for REE mineralisation in Granitoids around Miyasa area of Banswara district, large scale mapping of 100.0 sq km area on 1:12,500 scale was carried out. Mineralization in the area is marked by the presence of intense ferruginisation, occasional fresh sulphides of pyrite, chalcopyrite, arsenopyrite, malachite stains and bornite in granite, metabasalt and quartzite. Chunks of native copper and arsenopyrite were also reported in the study area. The analytical results of bedrock samples yielded 1164 ppm and 512 ppm of copper in Hilej area and near Sobaniya, respectively. REE values of Ba in 13 samples ranges from 1500 to 2425 ppm, Sr values 300 to 600 ppm. Sc values in eight samples ranges from 400 to 900 ppm. Zn value in one borehole sample yielded 2607 ppm.

During G4 stage reconnaissance survey for REE minerallization in Koshithal area in Rajsamand and Bhilwara districts, large scale mapping of 102.0 sq km on 1:12,500, scale was carried out. A total of 221 bed rock, soil, petrological, and petrochemical samples were collected to assess mineral potential and geochemical characteristics of the rocks of the area. Besides, 25 cu m trenching was laid on the suspected rare earth element (REE) mineralized zone. The analytical results of various types of samples did not show any anomalous concentration of REEs or any other mineral in the Kosithal block.

A G4 stage reconnaissance survey for REE mineralization was taken up in and around Parbati, Nahri, Nandsha, Nayakhera and Dulepura in Ashaholi area of Rajsamand and Bhilwara districts. During survey, a total 100 samples each of bed rock and soil, 10 petrochemical samples, 25 samples from pitting/trenching were collected. The lithological assemblages that were mapped in the Ashaholi block include calc-silicate rock, marble and amphibolites, migmatite gneiss and quartzo-feldspathic gneiss of Mangalwar complex later intruded by several pegmatite and quartz vein at places.

A G4 stage reconnaissance survey was completed with an objective to find the REE and RM potentiality in and around Kekri-Dhundri-Gulgaon area of pegmatite belt in Ajmer district. Large scale geological mapping on 1:12,500 scale was carried out an area of 100.0 sq km. During survey, 200 bedrock samples, 50 stream sediment samples, 25 samples for petrochemical analysis and samples for heavy mineral analysis were collected. Analytical results of 60 bed rock samples yielded ?REE value from 2.82 to 1198 ppm.

In Rajsamand and Bhilwara districts, G4 stage survey for REE mineralization in Raipur and Bemali area comprised mapping of 100.0 sq. km on 1: 12,500 scale and 700.0 sq km by Photo geology & Remote Sensing studies that include ASTER data processing including alteration zone mapping. Occurrences of allanite (REE bearing) grains were noticed in east of Dang ka Khera and west of Chawandiyan villages. The expected REE mineralized zone is almost 400 m long linear band with width is around 100-150 m. It is wider in the north and pinching towards south.

A reconnaissance survey comprised geological mapping on 1:12,500 scale for lithium and associated strategic minerals, REE, Rare Metal in Pichhli, Meghatari area, Nawada district, Bihar and Koderma district, Jharkhand was carried out. The extension of the Pichhli pegmatite was targeted for by means of taking traverses followed by pitting and trenching .The pegmatite at Pichhli village was noticed to extend further south for about 300 m in length and 20 m width. Apart from finding the extension of the pegmatite of Pichhli village, 07 new pegmatite bodies were identified emplacing the granite gneiss and mica schist with length ranging from 100 to 300 m and width of 8 to 20 m. The pegmatites were observed to contain economic minerals like mica, beryl, emerald, amazonite and lepidolite in the study area.

In Meghalaya, during reconnaissance survey for lithium and associated REE & RM mineralization in Umlyngpung block, East Khasi Hills district, mapping of 50.0 sq km area on 1:12,500 was carried out to map the different pegmatite and aplite veins intruding into the granite. The only lithium bearing mineral that could be identified in the field was tourmaline. The analytical results showed lithium values ranges from 20 to 64 ppm in grey porphyritic granite and aplite with maximum value of 78 ppm. Pitting and trenching were done across the veins to assess the continuity and most importantly to study if the veins have any lithium mineral phases.

In Rajasthan, preliminary exploration was taken up to assess the potentiality of lithium, rare metals and associated metals mineralization in Sibagaon area, Sirohi district. Significant values of beryllium ranging 123 ppm to 182 ppm, Ta 12 ppm to 135 ppm, and Rb 154 to 1046 ppm were recorded in pegmatites located during geological traverse around Palri, Sibagaon and Kaldari area. Few anomalous values of Rb (252 and 288 ppm) were recorded in pegmatites located in geological traverse around Rajpura and Kaldari area. Anomalous values of Nb (44 ppm), Ga (34 ppm) and Zr (308 ppm) were noted in pegmatites around Isra. Along the same traverse some lamprophyre dykes were also identified. Partial chemical results have shown anomalous enrichment of Zr (1789 and 1326 ppm).

STATE DIRECTORATES

Directorate Mines & Geology, Rajasthan

During 20119-20, regional and geological mapping for strategic minerals (REE) near villafe Dandali and Goyna Bhakar area in Sindhari tehsil, Barmer district was taken up with an objective to locate Rare-earth Elements minerals. An area of 15.0 sq.km on 1:10,000 scale and 1.0 sq.km on 1:4,000 scale was covered. Calcio carbonatite vein has been marked east of the nepheline syenite hilss near Rebariyo ki dhani school.It is intrusive in syenite rock. Exposures of syenite are noticed over 1.25 km x 0.45 km and 550 m x 250 m area towards east of Gangli.

Directorate Mineral Resources, Meghalaya

The investigation for REE around Sung valley, West Jaintia Hills was continued since 2016. A total 2.2 sq.km area was mapped on large scale (1:50000) and 9 sq.km area on small scale (1:4000). A total of 32 samples were collected for chemical analysis. Various lith units like rock phosphate, bauxite, clay, pyroxinite, dunite, etc were identified in the area.

Strategic Metals

Tin

GSI

In Gujarat, a G3 level preliminary exploration for strategic minerals / rare metals (Sn-W-Ta-Nb) in Nadri granite and pegmatites intrusive into Delhi supergroup of rocks, Sabarkantha district was carried out. The chemical data of a few samples suggest Sn (2-2281 ppm), Li (13-2800 ppm), Rb (76-2742 ppm) and Cu (4-2415 ppm) in the southern part of the block. The elemental dispersion map of Sn, Cu and Nb are overlapping and form an anomalous zone in the south eastern part of the Nadri Block. The Li-mineralization associated with Ta-Rb-F, is hosted in pegmatite, mica-fluorite rich greisen zones and mica rich granitoids and pegmatites.

A G4 stage reconnaissance survey for strategic minerals / rare metals (Sn-W-Ta-Nb) was taken up in late magmatic phase of Idar granite in Sabarkantha district. A total 100 sq km of area was mapped on 1:12,500 scale. The pegmatites and aplites occur as vertical as well as sub-horizontal intrusions into the Idar Granites. Dimension of these bodies vary from 15 cm to 1.5 m in width and 5 to 120 m in length. Presence of beryl and fluorite indicate the possibility of rare metals in pegmatites. Panning of soil samples carried out in RajchandraVihar and Sarangpur area also indicated presence of some heavy minerals. Aplites and microgranites hold the possibility of hosting rare metals. Molybdenite was observed in SendraAmbaji granite in Bhavangarh area.

In Himachal Pradesh, a G4 stage reconnaissance survey for Tin, Tungsten, Molybdenum, RM and REE in Nako granite, Kinnaur district involved large scale mapping of 65.0 sq km area on 1:12,500 scale and collection of 150 nos. of BRS, 10 nos. of XRD and 50 nos. of PS samples. Available analytical results showed highest value of total REE (?REE) is yielded in biotite schist of Morang Formation i.e. 498.42 ppm whereas the yield with lowest value of ?REE was in

pegmatite i.e. 3.29 ppm. Quartzite yielded a maximum ?REE value of 437.38 ppm and minimum value of 14.90 ppm. Calc silicate rock yield maximum ?REE value of 209.61 ppm and minimum value of 28.95 ppm. Leucocratic Granite of Nako Formation yield maximum ?REE value of 196.61 ppm and minimum value of 6.08 ppm. Pegmatite yield maximum ?REE value of 124.27 ppm and minimum value of 3.29 ppm. The maximum and minimum concentration of tin (Sn) are 89.4 ppm and 0.16 ppm from pegmatite and calc silicate rock, respectively. In calc silicate rock and granite, the maximum and minimum concentration of Tungsten (W) is 66.64 ppm and 0.5 ppm, respectively. In granite rocks, the maximum and minimum concentration of Lithium (Li) is 442.2 ppm and 8.13 ppm, respectively. In biotite schist and quartzite, the maximum and minimum concentration of Caesium (Cs) is 76.47 ppm and 2.00 ppm, respectively. In biotite schist and granite, the maximum and minimum concentration of Molybdenum (Mo) is 5.99 ppm and 0.5 ppm, respectively.

Tungsten

GSI

In Assam, A G4 stage reconnaissance survey for tungsten mineralization was taken up in Amgurigaon-Nellie- Ghgara area, Karbi Anglong and Morigaon district. Fine disseminations of sulfide minerals comprising mainly pyrite, pyrrhotite, chalcopyrite, covellite, pentlandite and arsenopyrite and few tiny grains of scheelite were also observed under UV Light within metavolcanics. The maximum value of tungsten 65.5 ppm was reported from quartzo feldspathic vein. Four bedrock samples of meta-volcanics yielded Gold (Au) values of 124 to160 ppb, 2 pit samples of metavolcanics yielded 174 ppb & 186 ppb of Gold (Au) and in 5 trench samples of the same metavolcanics, Gold (Au) value recorded 102 to 193 ppb. The meta-volcanic band recorded to a length varying from 500 m to 1 Km with width 25-50 meter. The presence of sulfide, scheelite and associated gold in study area is mainly confined to the meta-volcanics. A gold grain up to 10 microns in size was identified under Scanning Electron Microscope (SEM). The scheelite grains are associated with mainly pyroxene and sphene, the possible source to form scheelite, the required Ca may be released from pyroxene or sphene and W might have incorporated due to hydrothermal fluid release from granitic magma source to form the scheelite.

In Meghalaya, a G4 stage reconnaissance survey for tungsten mineralisation in Manai-Mairang block, West Khasi Hills district involved large scale mapping of 50.0 sq km area on 1:12500 scale. Pegmatite and quartz veins, the target zone of mineralization were intruded along and across the foliation plane of quartz mica schist, calc silicate rock and foliated granite. Thickness of quartz veins and pegmatites varies from 5 cm to 2 m. The surface indications of mineralization were observed in the form of greisens veins, boron metasomatism, etc. Quartz-muscovite-tourmaline greisen transecting pelitic schists observed at Manai village have a thickness of 25 cm and shows bluish fluorescence under UV light. Quartz-muscovite greisen of 0.8 to 1.3 m thick is developed at the contact of pelitic schist and granite towards 1.7 km north of Mawiong village. Towards 1.5 km northeast of Thapbulong village, greisenisation is observed at the vicinity of a pegmatite vein containing large K-feldspar ranging size from 2 to 3 cm, quartz, etc. Maximum values of W, Sn, Mo, Li, Ta, Nb, Y, Hf, Cu, Pb, Zn and TREE from the chemical analytical results of bed rock samples showed 17.98 ppm, 81 ppm, 15 ppm, 79 ppm, 37.15 ppm, 159 ppm, 488 ppm, 18 ppm, 101 ppm, 737 ppm, 228 ppm and 1418 ppm, respectively.

In Rajasthan, during G2 level general exploration for tungsten and lithium mineralisation in and around Rewat hill, Degana, Nagaur district, detailed mapping of 1.60 sq km area on 1:2000 scale and drilling of 198.15 m was completed. The borehole RJND-2 intersected two major mineralized quartz/pegmatite veins at a depth of 76.63 m and 152-164 m along the borehole having width of 29 cm and 50 cm respectively. Wolframite (FeMnWO4) grains of 1 mm to 2 cm are occurring in the form of dissemination within quartz veins and along the contact of quartz vein and granite. Chalcopyrite, pyrite and pyrrhotite also occur at various depths (54-123 m) in association with wolframite in the form of dissemination and vein filling. Greissenised granite is reported at the contact of these W mineralized quartz veins along with greisen which are also mineralized. The greissenised granite shows enrichment of Li and Rb. Assay values of 12 core samples collected

along mineralized zones yielded tungsten value 230.81 ppm to 41906.98 ppm. The assay value of lithium in these core samples varies from 153 ppm to 1809 ppm. Assay value of 17 channel samples showed average value of 0.16% of tungsten (W) and maximum value up to 0.95%; average value of 0.08% of Lithium (Li) was reported in the area.

During G4 stage reconnaissance survey for tungsten and associated rare metal mineralization in Luharcha, Bekriya & Sei dam area of Udaipur district, Rajasthan, an area of 100.0 sq km was mapped on 1:12500 scale. Based on field observations, the scheelite bearing skarns were inferred in the central and southern part of the area mostly in and around Kyari, Loharcha, Bhutgani, Teja-ka-Vas and Bekriya village area. The mineralization was inferred by the mineral assemblage observations based on ample deuteric alterations reactions and epidote bearing retrograde skarnization.

A reconnaissance survey for tungsten and associated mineralisation around Dumani-Tamroli – Degana – Gindisar - Nund-Mithria area, Nagaur district involved large scale mapping of 50.0 sq km area on 1:12,500 scale and 740.5 m drilling in 07 vertical boreholes. Boreholes varied depths from 75 m & 124.5 m. The granite in the study area was seen in the excavated material of deep tube well located northern, north-western and north-eastern of Rewat hill. Analysis of 03 sample collected near to Rewat Hill, Himmatnagar and Tilnish village showed tungsten value 210.58 ppb, 1.06 ppb and 1.01 ppb, respectively. The tungsten values of rest of the samples were below detection limit (0.5 ppb). In Sirohi district, reconnaissance survey for W and associated rare metals mineralization was taken up in south of Udwaria area. Two skarn zones were identified in rocks of Reodar formation of Sirohi Group. Surface indications of mineralization in the area are not quite prominent. One skarn zone, 2.5 km north-west of Udwaria was identified where calc-silicate rock intercalated with andaluste- muscovite-biotite schist and is associated with garnetifeours quartz vein. This has been considered as a favourable zone of schellite mineralization in the study area. Besides, some pyrite specks were observed in quartz-biotite-muscovite schist and basalt near Asawa.

In Uttarakhand, during reconnaissance survey for tungsten, tin, molybdenum, Rare Metal and REE mineralization in and around Jatoli Granite, Bageshwar district, an area of 50.0 sq km was mapped on 1:12,500 scale. Two types of the Jatoli granite were mapped i.e. (i) Tourmaline, garnet bearing muscovite-rich granite with minor or no biotite in the southern part and (ii) Biotite-rich granite with occasional garnet in the northern part. Along with bedrock samples from different lithologies, systematic Channel sampling was carried out in the marble-granite contact zone near Malyadhaur to check for potential skarn-mineralization and also near Dhur, where a 1 m thick quartz vein is found within granite mylonite. Since large parts of the area are inaccessible and the terrain is extremely rugged, a total of 19 samples of panned concentrates of heavy minerals were collected from streams and slope wash.

MECL

In Maharashtra, a G4 stage exploration for tungsten mineralisation was carried out with an objective to prove the occurrence of ore body in the intervening area in the Kuhi-Khobna-Agargaon gap area block,established the consistency and reliability of the grade zone over a promising strike length and upto 50 m verticle depth in Nagpur district. Exploration involved mapping of 57.0 sq. km. on 1:12,500 scale along with collection of 449 samples for chemical analysis of different elements and 52 samples for petrographic/mineragraphic/etc studies. Besides, a total of 5 borholes were drilled to a cumulative of of 945.0 m.

Vanadium

GSI

In Arunachal Pradesh, a G3 level preliminary exploration for Vanadium and associated minerals around Saiya area, Lower Subansiri district involved detailed mapping of 1.0 sq km area on 1:2000 scales with 50 m3 of pitting/trenching. In the study block, vanadium mineralization and fixed carbon values are hosted in carbonaceous phyllite/ schist bands. A cumulative strike length of 2650 m of carbonaceous phyllite bands with thickness ranging between 20-200 m has been confirmed in

the mapped area. The vanadium mineralization in the area has been considered as strata bound bedded deposit. Initial chemical results indicated Vanadium values range from 978 ppm to 5851 ppm and Fixed Carbon values from 10.96% to 11.48%. During G4 stage reconnaissance survey for vanadium, graphite, gold and associated minerals in Pyunli, Yachambra and Kano villages, Lower Dibang valley district, an area of 50.0 sq km was mapped on 1:12,500 scale. Two samples of peridotite body yielded a value of 46.59% & 44.93% of MgO; 1118 ppm & 2469 ppm of Cr and 2191 ppm & 2235 ppm of Ni.

In Maharashtra, a G4 stage reconnaissance survey for locating vanadiferous titanomagnetite (V-Ti magnetite) mineralization in ultramafic-mafic complexes of Dongargarh supergroup of rocks in Kanholi-Surtoli area, Bhandara District comprised large scale mapping of 60.0 sq km area on 1:12,500 scale and collected samples for rock and mineralogical studies to ascertain the mineralisation potentiality. The vanadiferous titanomagnetite mineralisation is very closely associated with small scattered intrusive bodies of gabbro, which is intermittently exposed for about 1.5 to 2.0 km in length and 500 to 700 m in width. The mineralization is associated with magnetite and ilmenite. The goldmanite, vanadium bearing garnet and mukhinite, a vanadium bearing epidote mineral were newly reported from the study area.

Molybdenum

GSI

In Madhya Pradesh, a G4 stage reconnaissance survey for molybdenum and associated mineralization in Bendari-Basari-Karri area, Chhatarpur district involved detailed geological mapping on 1:2000 scale, large scale mapping on 1:12,500 scale and geophysical (SP, IP and Resistivity) survey in the area. Molybdenum and associated sulphide mineralization mostly reported in the medium to coarse grained granite, fine to medium grained granite and associated quartz/ pegmatite veins. Geophysical survey indicated medium to coarse grained granite and fine to medium grained granite is most favourable for Mo and associated mineralisation in Bendari block. Analytical results of BRS samples from this block showed Mo value up to 1718 ppm. As per integration of geological, geophysical and partially received analytical results, approximately 500 m x 400 m area in south of Bendari village was recommended for further close spaced geophysical mapping followed by scout drilling to understand the depth persistence of Mo Mineralisation in Bendari block.

A G4 stage reconnaissance survey for molybdenum and associated mineralization was taken up in parts of Bundelkhand Granitoid Complex (BGC) in Bikrampur- Para area, Chhatarpur district. In the study area, surface indication in the form of disseminated grains of pyrite, chalcopyrite and galena were noticed within non-porphyritic medium grained biotite granite near Birauna village. Molybdenum mineralization observed nearby Bikrampur, north of Kesaripura and Para village within non-porphyritic medium grained biotite granite. Manpur, Imiliya, Bikrampur, Para, Chaubar and Birauna area showed presence of disseminated sulphides comprising of pyrite, chalcopyrite and few specks of azurite and also seen few specks of molybdenite within medium grained granite of BGC.

In Jabalpur district, G4 stage reconnaissance survey for tungsten (W), molybdenum (Mo) and associated mineralization was taken up in Madanmahal Granite, Halka and Pipariya area. Numerous quartz, pegmatite, quartz-carbonate and aplite veins are present within amphibolites and mica schist. Few samples showed bluish white fluorescence (probably powellite and scheelite) under shortwave UV light. As per the available chemical analysis data, Cr showed high values in amphibolite (upto 1125 ppm), mica schist (1272 ppm) and chloritic alteration zone (upto 1732 ppm). MnO concentration is also high (19.50 wt. %) in a quartz vein. Ni showed values (upto 1285 ppm) in muscovite bearing milky white quartz vein. Chemical analysis data revealed slightly higher concentration of Cu (09 to 125 ppm), Zn (10 to 90 ppm) and Co (09 to 340 ppm). W and Mo concentration were not appreciable from bed rock sample and it ranges from 0 to 8.17 ppm for W and 0.25 to 11.30 ppm for Mo in granite and vein samples. In a bed rock sample from amphibolite, the tungsten value showed slightly higher concentration of 22.23 ppm.

In Tamil Nadu, G3 level Preliminary exploration for molybdenum and associated mineralization was carried out in Vellakkal central block, Segment- A, Harur - Utthangarai molybdenum belt, Krishnagiri

district. Drilling for Ist level in 5 boreholes were completed and drilling in two boreholes were progress. In total, 623.2 m of drilling had been completed. All the first level boreholes have intersected the primary shear zone with an average thickness of around 30 m at anticipated depth. Mo mineralization as fine dissemination, specks and smears were noticed in all the boreholes within a mineralized zone ranging up to 2.5 m in thickness. Besides, other sulphides viz. chalcopyrite, pyrite, galena were also encountered in the area.

In Krishnagiri district, during G3 level preliminary exploration for molybdenum and associated mineralization in Nochchipatti block of Harur-Uttangarai molybdenum belt, detailed mapping of 1.50 sq km area on 1:2000 scale was carried out. Three boreholes were drilled to a cumulative depth of 379.9 m. Two parallel shear zones were demarcated in the area. The results received for 11 bed rock samples and 36 pitting & trench samples showed Mo ranges from 0.3 to 108.8 ppm, Cu 10 to 204 ppm, Pb 10 to 611 ppm, Zn 20 to 288 ppm and Ni 10 to 98 ppm.

Nickel

GSI

In Andhra Pradesh, during G4 stage reconnaissance survey for nickel and basemetal mineralization in Rachigaripalle area, Kadapa district,an area of 80.0 sq km was mapped on large scale. The rock types observed in the area include quartzite, conglomerate, sill, shale and dolomite. Southern part of the study area is purely dolomite. In the sill, vesicular structure with secondary infilling like chrysotile was also observed. The minerals are occurring as sulfide dissemination in many places near to Vemula, Bakkanagaripalle.

A G4 stage reconnaissance survey for nickel and copper mineralization in basic sills around the Gandikota Area, south-western margin of Cuddapah basin involved Large-Scale Mapping of the area. Indications of sulphide mineralization were observed in all the basic sills. Ore petrography study showed presence of pentlandite, pyrrhotite, chalcopyrite and pyrite in the representative samples of basic sills. Analytical results showed high Cu values in BRS-50 (0.05%), BRS-81 (0.06%), BRS-104 (0.07%) and BRS-125 (0.33 %); high Ni in BRS-49 (0.02%), BRS-24 (0.04%) and BRS-82 (0.18%); and for Pb it was (0.66%), Y (0.06%), Zn (0.06%) in BRS-82.

In Gujarat, a G4 stage reconnaissance survey for Ni, Co and PGE in and around Hathipura and Phojdar Kampa, in the eastern part of Dadhaliya ultramafic complex, Aravalli district covered large scale mapping of 100.0 sq km area on 1:12500 scale. The mineralisation in the rocks of the area is sporadic in nature. Apart from this, secondary manganese mineralization in fracture planes of quartzite was reported near Ghanta village. Chemical analysis results showed MgO value 18.89 % to 42.12%, Co value 100 to 382 ppm, Cr value 1019 to 3172 ppm and Ni value 1006 to 2709 ppm.

A G4 stage reconnaissance survey for Ni, Cr and associated base metal mineralizationwas taken up in Jhanjhari block, Dungarpur and Udaipur districts, Rajasthan. The mineralisation in the mapped area was mainly asbestos which are the altered product of predominantly serpentinite of ultramafic bodies in the Kundol and Bhanmer villages. Serpentine asbestos/chrysotile asbestos occurs in serpentine bearing rocks such as altered peridotite which are altered in the study area (potential zone for Ni and Cr mineralization). Analytical results of some BRS samples reported Cr values ranging between 2100 ppm to 4350 ppm and Ni values between 1800 ppm to 3250 ppm.

In Jammu & Kashmir, reconnaissance survey for Ni-PGE in Kyun Tso mafic-ultramafic body in Shurok-Sumdo area, Leh district was taken up on expedition basis. One band of chromite, having thickness 1 m and length 30 m, and three bands of 30 cm, 15 cm and 75 cm thick and 6 m, 8 m and 10 m in length, respectively was observed in the area. Nickel value in samples varies from 3000-5325 ppm with highest value 5325 ppm in dunite body. The average Ni value is 1915.1 ppm. The Cr value in samples varies from 10 % to 40.62% in the chromite bearing dunite and peridotite bodies.Besides, Co value ranges from 2 ppm to 139 ppm. Only two values of Pd were analyzed above 10 ppb and Pt in 7 samples ranges from 10.2 ppb to 18.2 ppb.The average MgO content of the area is 33.43%. In case of Vanadium the appreciable values were noticed in the dolerite dykes

In Manipur, G4 stage reconnaissance survey for Ni-Cr-PGE and associated basemetal around Khudengthabi-Yangoupokpi area in part of Manipur Ophiolite belt, Tengnougpal district covered large scale mapping of 50.0 sq km area and 50 cu m of

pitting/trenching. The analytical indicated Cr (541 to 6644 ppm), Ni (900-16600 ppm), Cu (5-95 ppm), Pb (15-70 ppm), Zn (20-130 ppm), Co (50-330 ppm), V (14-484 ppm) from peridotites and serpentinites. Although, Ni-sulphide mineralization is not observed, it is intriguing to note the high concentration of Ni in the peridotites. In the limonitic zone of laterite, high concentrations of Fe2O3 (up to 55.03%) were recorded. Typical concretionary type of laterite analyzed TiO_2 (0.49%), SiO_2 (24.69%), Al_2O_3 (9.93%), Fe_2O_3 (43.66 %) MgO (1.97%), MnO (0.82%), CaO (0.01%), Na_2O (0.05%), K_2O (0.4%), P_2O_5 (0.07%).

In Karnataka, a G4 stage reconnaissance survey for nickel and copper mineralization in the mafic-inultramafic intrusives around Turuvanur and Kunabevu areas, Chitradurga Schist Belt was taken up.The survey comprised detailed mapping of 2 sq km on 1:2000 and a total of 704.65 m scout drilling in four boreholes. There was no surface indication of mineralization observed during the field. However, fine disseminations of sulphides within carbonate veins were observed in core samples. Bedrock samples analyzed and indicated Ni values ranging from 920 to 21200 ppm. Overall, Ni values range from 1150 to 21200 ppm in bed rock samples and from 65 to 15520 ppm in trench samples. High magnetic susceptibility zones were recorded in few anomalous zones particularly over ultramafic unit.

A G3 level preliminary exploration for Komatiite-hosted Ni-PGE-Au mineralization in the mafic-ultramafic rocks around Banasandra, Tumkur district comprised detailed mapping, systematic sampling and drilling in the study area. Three mineralized zones were identified in the one borehole. The drilled core showed 3 mineralised zones (i) Zone-I, 15.7- 30.0 m: (Ni: 0.58% & Co: 242 ppm), Zone-II, 44.3 to 54.8 m: (Ni: 0.62% & Co: 387 ppm) and Zone-II, 106.5 to 114.45m: (Ni: 0.59% & Co: 332 ppm). Analytical results of 3 Regolith samples showed anomalous PGE values (100 to 232 ppb; total PGE), indicating the possibility of PGE-enrichment in the weathering profile. Ground geophysical survey indicates the possible magnetite-rich zone and associated secondary Ni-enrichment at South Banasandra block.

A G4 stage reconnaissance survey for nickel and copper mineralization in the mafic, inultramafic intrusives around Turuvanur and Kunabevu areas, Chitradurga Schist Belt was taken up.The survey comprised detailed mapping of 2 sq km on 1:2000 and a total of 704.65 m scout drilling in four boreholes. There was no surface indication of mineralization observed during the field. However, fine disseminations of sulphides within carbonate veins were observed in core samples. Bedrock samples analyzed and indicated Ni values ranging from 920 to 21200 ppm. Overall, Ni values range from 1150 to 21200 ppm in bed rock samples and from 65 to 15520 ppm in trench samples. High magnetic susceptibility zones were recorded in few anomalous zones particularly over ultramafic unit.

In Rajasthan, G4 stage reconnaissance survey for Nickel and associated PGE mineralization in Gokulpura-Hiranta - Sarkan area of Rikhabdev ultramafic rocks, Dungarpur district involved mapping of 100.0 sq km area on 1:12500 scale and 700 sq km ASTER image processing. The main host rock for Ni, Cr, and PGE is serpentinite in this area. Four mineralized zones were identified during the survey of the area. They are (i) East of Gokulpura - The mineralized zone was observed within siliceous dolomite extend for a strike length of about 200 to 250 m with zone thickness of 15 to 20 m, (ii) North-west of Sarkan Sain- Within serpentinite, Stringers and disseminated patches of chromite associated with magnetite bands extend for a strike length of about 15 to 20 m with zone thickness of 1 to 2 m, (iii) South of Hiranta – mineralized zone is observed within serpentinite extend for a strike length of about 80 to 100 m with zone thickness of 3 to 4 m and (iv) East of Bhandariya – highly iron rich oxidized zone is noticed within serpentinite extend for a strike length of about 15 to 25 m with zone the thickness of 1 to 2 m. The chemical analysis result of 29 number of bed rock samples collected from serpentinite showed Ni, Cr, and Co content varies from 66 ppm to 0.57%, 139 ppm to 1.42 % and 19 ppm to 656 ppm, respectively.

During G4 stage reconnaissance survey for nickel and associated PGE mineralization in Rikhabdev Ultramafic rocks of Khirwara-Mandwa-Katev area, Udaipur and Dungarpur districts, an area of 100.0 sq km was mapped in the scale of 1:12500. Mineralisation in the area is confined to the serpentinite and its derivatives such as talc tremolite schist and talc carbonate schist. Malachite staining with high ferrugenisation was noticed in serpentinite on top of a hill in south of Khirwara town. The analytical results of 137 bedrock samples indicated Ni value ranging from 15 ppm to 0.56%. The highest

value was recorded in talc chlorite schist to north of Dhelana area with value of Ni 0.15%. Cr ranges from 81 ppm to 1.3%. The highest value was recorded in carbonate derived from serpentinite in the south east of Dhelana. Co content in the area varies from 0.5 ppm to 312 ppm. Chemical analysis result of 112 samples indicated Cu 5 ppm to 994 ppm, Pb 1 ppm to 119 ppm and Zn 5 ppm to 262 ppm.

A G4 stage reconnaissance survey for nickel and associated PGE mineralisation in Rishabdev Ultramafic rocks of Dewal-Khanmin-Wagdari area, Udaipur and Dungarpur districts was taken up. During study, an area of 100.0 sq km was mapped on 1:12,500 scale.Mineralisation is manifested by the presence of oxidation, ferruginisation and malachite stain within serpentinite and talc-chlorite-schist.The analytical results of 70 bedrock samples showed Ni, Cr, and Co content varies from 161 to 2497 ppm, 491 to 3796 ppm and 29 ppm to 117 ppm, respectively. The mean value of Ni, Cr and Co is 1894 ppm, 2263 ppm and 86 ppm, respectively. The highest value of Ni, Cr and Co is recorded in serpentinite near Balwara village area.

A G3 level preliminary exploration for nickel and associated mineralisation in Hemasar block, parts of Bidasar ophiolite suite, Churu district was carried out. An area of 2.0 sq km was taken up for detailed geological mapping with 1200.0 m of drilling in the study area. A cumulative of 1040.0 m of drilling was carried out in nine with depth ranging from 80 m to 220 m. The analysed values of core samples of borehole-1 showed Ni ranges from 50 ppm to 2200 ppm with most of the values falls in between 1200 ppm to 1700 ppm. The samples of borehole-2 and borehole-3 showed value for Ni varies from 15 ppm - 370 ppm and 20 ppm - 715 ppm, respectively.

A G4 stage reconnaissance survey for nickel and associated PGE mineralization in Rikhabdev Ultramafic rocks of Dewal-Khanmin-Wagdari area, Udaipur and Dungarpur districts was taken up. During study, an area of 100.0 sq km was mapped on 1:12500 scale.Mineralisation is manifested by the presence of oxidation, ferruginisation and malachite stain within serpentinite and talc-chlorite-schist.The analytical results of 70 bedrock samples showed Ni, Cr, and Co content varies from 161 to 2497 ppm, 491 to 3796 ppm and 29 ppm to 117 ppm, respectively. The mean value of Ni, Cr and Co is 1894 ppm, 2263 ppm and 86 ppm, respectively. The highest value of Ni, Cr and Co is recorded in serpentinite near Balwara village area.

MARINE & COASTAL SURVEY GSI

Detailed exploration for polymetals (Co, REE, Ni and Zn etc.) in the Fe-Mn crust/nodules in the An During regional exploration for polymetallic nodules off Lakshadweep Sea, an area of 4185 km^2 off Lakshadweep Sea was surveyed by backscatter imaging/multi-beam echosounder system along with magnetic and gravity surveys and sediment sampling to identify the seabed morphology and tectonic set up favourable for augmenting offshore marine resources off Lakshadweep Sea.Forty-four surface sediment samples (grab) in 10 km X 10 km grid and two gravity core (GC) were collected from the investigation area. Geochemical studies of surface and sub-surface samples show that there is an enrichment of manganese content in the sediment along with slight enrichment of Cu, Ni, Co elements in the sediments. High geochemical affinity between $CaCO_3$ and Sr is evident from the chemical data of sediments.

An area of 6000 km^2 was surveyed by backscatter imaging/multi-beam echosounder system along with magnetic and gravity surveys and sediment sampling to identify the seabed morphology and tectonic set up off Lakshadweep Sea in search of Fe-Mn nodules in the abyssal plains as a part of National Programme on High Resolution Seabed Mapping and Natural Resource evaluation in EEZ of India and beyond.The geophysical survey by gravity and magnetic brought out three dominant anomaly zones in the area i.e a low free air (FA) gravity (Zone-I) cum moderate magnetic anomaly (Zone-III) in the eastern side, a high value of FA gravity (Zone-II) cum high magnetic anomaly (Zone-II) in the central part and a moderate free air (FA) gravity (Zone-III) cum low magnetic anomaly (Zone-III) in the north western side of the area. Geochemical studies reveal that sediments having high $CaCO_3$ show high Sr content. There is an enrichment of Mn content in surface sediments. Mn is a redox sensitive element accelerating the growth of Mn micronodules. Mn/Al ratio varies from 0.03 to 0.06 (average 0.04) indicating that the sediments are derived from Mn rich (in offshore) areas. The Total REE concentration in surface sediments varies from 90.31 to 155.22 (avg. 120.75) ppm. Sparsely distributed Mn micronodules are there in the investigated area as infillings and

encrustations. The chemical data showed that there is an enrichment in the Mn content in the sediments but the formation of macro nodule is hindered by factors like the sediments from the Indus Fan, bioturbation, under water currents, proximity to continents etc.

An area of 1600 sq. km in the continental shelf off Point Calimere,Tamil Nadu coast was taken up for preliminary assessment of phosphorite in the East Coast Margin of India. Surface sediments collected from shelf area are marked by the presence of glauconite and phosphatic materials. The phosphatic material in the survey area mainly occurs in form of concretions, peloid/pellets, sand sized phosphatic grains, micro-concretions, steinkerns, ferruginous rock pieces and phosphatized fish bones. The phosphatic material is confined within the water depths of 174 m to 370 m and associated mainly with silty sand and sandy clay sediments. At two locations, it was observed that phosphatic material exist within the ferruginous rock.The size and shape of the phosphatic concretions vary widely in the study area. Size of phosphatic nodules varies from 0.5 cm x 0.5 cm to as big as 6 cm x 3 cm. An area of 550 sq. km was delineated in the surveyed area based on the concentration of P_2O_5 in the recovered phosphatic concretions and nodules. It is observed that P_2O_5 enriched phosphatic nodules/concretions are recovered from the terrace like features on the outer shelf zone. About 60% of the phosphatic materials recovered are of fertilizer grade (>16%). The average P_2O_5 content in these samples is 16% while its maximum value going up to 23% at places.

During preliminary search for heavy mineral resource in the inner shelf area off Anjengo, South Kerala, a total of 67 vibrocore samples were collected within the depth of 45.9 m to 63.5 m in 2 km X 2 km grid. The maximum core recovery is 4.2 m (VC-04) and minimum core recovery is 0.29 m (VC-42). Presence of heavy minerals were observed in the finer fractions of top sediments. Heavy mineral occurrence is noticed in the fine fractions of the sandy sediments in the bottom.The total heavy mineral (THM) in the top one meter of the sediment column ranges between 0.45 and 4.31 wt. % with an average value of 2.19 wt. %. THM content concentration is maximum in +120 and +230 fractions.

Preliminary assessment of heavy mineral resources in the offshore sediments off Paravur, south Kerala over an area of 57 sq. km was taken up. Shallow seismic survey of 98 lkm and single beam bathymetric survey of 98 lkm were also carried out to study the disposition of sediment on and below seabed.A total of 64 vibrocore samples had been collected during the cruise at 1 km x 1 km grid pattern. The minimum and maximum length of cores recovered is 0.30 m and 3.88 m respectively and average length of cores recovered is 2.35 m.

An area of 52 sq. km within the continental shelf domain off Paravur **(**Block-III), Kerala was covered for preliminary assessment of heavy mineral resource.Thick sedimentation is observed in the eastern part of the area where water depth varies from 26 to 34 m. Bottom sample consists of medium to coarse sand/ compact oxidized clay. Fining upward sequence is observed in most of the cores.Heavies are mainly observed in the fine sand.The concentration of bulk heavy mineral observed in analysed samples varies from 0.8 to 3.7 wt. % with an average of 1.95 wt. %. Major heavy minerals present are sillimanite and ilmenite.

A preliminary assessment of heavy mineral resources in the offshore sediments off Kollam (Block-II), South Kerala was carried out covering an area of 50 sq. km. During the cruise, the area had been covered with 110 lkm of bathymetric and 212 lkm shallow seismic surveys. A total of 55 VC samples were collected in 1 km X 1 km grid pattern in the exploration area. Coarse fraction studies indicate that the sediment is dominated by terrigenous content with only 10-12% biogenic content. A large number of carbonate ooids (white and brown colour) are also observed in sediment. The sandy sediments contain considerable amount of heavies, mostly in finer fraction. The heavy mineral assemblage in the sediment includes Ilmenite, magnetite, garnet, rutile, pyroxenes, amphiboles, epidote etc.

A preliminary assessment off Kollam (Block-I), South Keralawas taken up to augment the resources of economic heavy minerals in the offshore area of 55 sq. km which is just adjacent to nearshore domain off Quilon. Bathymetric survey was carried out along 60lkm. The heavy mineral content ranges from 0.5 wt. % to 7.38 wt. %. VC-36 yielded maximum heavy mineral content of 7.38 wt. %.

To evaluate placer mineral resources in the territorial waters east off Bhimunipatnam, Andhra

Pradesh, 77 vibrocore samples were collected in 1 km x 1 km grid covering an area of 60 sq. km within water depth ranging from 21.64 to 42.43 m.The analysis reveal that the garnets are of almandine variety, TiO_2 content in rutile ranges from 99.63% to 99.71%. The Total Heavy Mineral (THM) and Total Economic Heavy Mineral (TEHM) concentration in sub-surface level from 0-1 m decreases with increasing depth and also decreases with fraction size. In sub-surface level (0-1 m), the TEHM ranges from 0.096 to 9.301 wt. % with an average value of 2.805 wt.In sub-surface level of 1-2 m, the TEHM ranges from 0.356 to 12.494 wt. % with an average value of 1.858 wt. %. In sub-surface level of 2-3 m, the TEHM ranges from 0.741 to 6.885 wt. % with an average value of 2.114 wt. % and in sub-surface level of 3-4 m, the TEHM ranges from 0.743 to 10.245 wt. % with an average value of 3.393 wt. %.

During preliminary assessment of placer mineral resources in the territorial waters off Rajapuram (South of Bavanapadu), North Andhra Pradesh Coast, an area of 60 sq. km was covered with 96 lkm of bathymetric survey and a collection of 77 vibrocores.All the surface sediments are enriched with considerable amount of heavy minerals. Bulk heavy mineral concentration in sediment varies from 2.04 wt. % to 21 wt. % up to 4 m below seafloor.

A preliminary assessment of placer mineral resource in the shelf area off Vizhunthamavadi, Nagapattinamdistrict, Tamil Nadu was taken-up over an area of 70 sq. km. During the cruise, a total of 80 nos. vibrocore sediment samples were collected in 1 km x 1 km grid covering an area of 70 sq. km within water depths of 14.8 to 37.8 m.

A preliminary search for placer mineral resource was taken up in the nearshore area off Bavanapadusector, north Andhra Pradesh coast.During the investigation, survey of 50 sq. km area in the near shore stretch off Bavanapaduwas carried out to assess the heavy mineral placers resource potential and characterization of heavy minerals up to 10 m of water depth. The heavy mineral study of the seabed sediments indicated that the bulk weight percentage of total heavy minerals varies from 0.43 wt.% to 29.08 wt.% with an average of 6.81 wt.%.

During regional search for placer mineral occurrence in the nearshore area off coastal stretch between Vaippar and Vembar, Thoothukkudi District, Tamil Nadu,an area of 120 sq. km in nearshore domain lying within 10 m water depth off coastal stretch extending from Vaippar to Vembar of Thoothukkudidistrict, Tamil Nadu was explored with systematic bathymetric survey and 1 km X 2 km gridded seabed sediment sampling to study the spatial distribution of major placer minerals and to demarcate the zones of higher concentration of heavy minerals.A total of 60 nos. of seabed sediment samples were collected with Van Veen grab sampler at the grid interval of 1 km X 2 km to evaluate the heavy mineral concentration in the near shore area in the coastal stretch between Vaippar and Vembar within the maximum water depth of 11 m. Along the shoreline, 12 Nos. of sediment samples were collected within the swash zone in the coastal stretch between Vaippar and Vembar.

A preliminary investigation was taken up for polymetals in the Fe-Mn Crust/Nodules in the southern part of West Sewell Ridge and regional search for polymetallic nodules in Sewell Rise, Andaman Sea: A total area of 2000 sq. km including the summit area of West Sewell Ridge (WSR) and Sewell Rise (SWR) of Andaman Sea bed was surveyed for polymetallic Fe-Mn crust/ nodules. Fe-Mn nodules are rich in Co, Cu, Ni, Zn, Li, REE & PGE. The Fe-Mn nodules, crusts and encrustations were found to occur embedded in calcareous sand within basaltic rock pieces and their size and shape vary from place to place. The nodules vary in size from 2 cm X 2 cm to 20 cm X 20 cm and are black to brown in colour. One polynodule was recovered from West Sewell Ridge (WSR). Nodules are massive to multi layered in nature. Layer thickness varies from few mm to 3.5 mm. The Fe-Mn crusts are layered masses of Fe-Mn with a thickness of 1 to 3 cm. The Fe-Mn encrustations are amorphous.

During preliminary assessment of placer mineral resources in the territorial water off Chilka- Nuapara, Odisha Coast, an area of47 sq. km was covered with vibrocore grid sampling in 1 km X 1 km grid pattern.A total of 52 vibrocore samples were collected with core length varying from 0.26 m to 1.78 m with an average of 0.63 m.Placer mineral content in the explored area varies from 3.35 to 19.02 wt. %. Placer minerals identified are ilmenite, garnet, sillimanite, zircon, monazite, rutile while other non-economic minerals are hornblende, pyroxene.

Platinium Group of Metals (PGM)

GSI

In Karnataka, G4 stage reconnaissance survey for platinum group elements (PGE), nickel and gold mineralization in Kalmangi Layered ultramafic complex and parts of HungundKushtagi schist belt, Raichur and Koppal districts involved large scale mapping of the area. The highest values of gold and copper were recorded from smoky quartz vein (Au- 28 ppb) and meta-rhyolite (Cu- 1300 ppm) located west of Bhogapur village. The analytical values of total PGE in bedrock samples were ranging from 6 ppb (only Pd) to 161 ppb (150 Pt+11Pd). Chemical analysis and lab studies of all samples are awaited. A G4 stage reconnaissance survey was taken up in search of platinum group elements and nickel between Gollarhatti and Donnekoronahalli area in Chitradurga and Chikmangalur districts. Mineralization is manifested in the form of magnetite and chromite. Based on the surface manifestation of magnetite, chromite, sulphide mineralization and surface alteration, three feeble narrow anomalous zones are identified.

In Kerala, a G3 level preliminary exploration for platinum group elements in Kalkandi block, Attapadi Valley, Palakkad district involved detailed mapping of 1.0 sq km area on 1:1000 scale in Kalkandi block. A potential PGE mineralized zone in the sulphide rich zone was traced for a strike length of 400 m with width varying from 0.50 to 3 m towards northern part of the mapped area. This is identified as the eastern extension of the already established mineralized zone in the corundum and diaspore bearing magnetite in the gabbro which is located to the NW of Temra. Olivine-websterite recorded Cu values up to 180 ppm, Ni values up to 975 ppm and Cr values up to 2200 ppm.

In Madhya Pradesh, G4 stage reconnaissance survey for Platinum Group of Element (PGE), Chromium (Cr) and Nickel (Ni) bearing magmatic rocks of the Padhar mafic-ultramafic suite was taken up in and around Padhar, Chikhli, Dhappa, Temra and Gondra villages in Betul Belt. Large scale mapping of 100.0 sq km area on 1:12,500 scale was carried out in the area. Seven possible mafic and ultramafic bodies were identified within the Padhar mafic and ultramafic complex. XRD studies revealed nickel bearing mineral i.e.Welleseite in the serpentinizedclinopyroxenite, and Fe-Mg-spinel, Chromite, corundum and diaspore bearing magnetite in the gabbro which is located to the NW of Temra. Olivine-websterite recorded Cu values up to 180 ppm, Ni values up to 975 ppm and Cr values up to 2200 ppm.

In Meghalaya, during G4 stage reconnaissance survey for PGE, Ni, Cr around Mawpyut area, East Khasi and West Jaintia Hills district, a total area of 50.0 sq m on on 1:12,500 scale was mapped. Chemical analysis result of 18 BRS and 5 stream sediments samples have shown Au values ranges from 100 to 410 ppb. Value of Au in gabbroic rock showed encouraging values. Au value in BRS samples varies from 240 ppb to 410 ppb, 240ppb, 260ppb, 300ppb, 350ppb, 410ppb.Value of Pd & Pt ranges from <10 to 25 ppb and <5 to 17 ppb, respectively.During G3 level preliminary exploration for PGE, Ni, REE and associated minerals in Northeast of Mawpyut, West Jaintia Hills district, an area of 2.2 sq km mapped on 1:1000 scale in NE of Mawpyut village and a cumulative depth of 475.30 m was drilled in four boreholes. A tentative sulphide bearing mineralized zone within the pyroxenite and gabbro was demarcated at right bank of Mynkjai Nala for a length of 800-1000 m with width of 80-120 m. The surface and sub-surface samples yielded the Pd value ranges from <10 - 35 ppb; Pt <5 - 28 ppb, Ir<3 - 35, Ru 9 - 122 & Rh <3 ppb; Cr ranges from 871 to 4569 ppm; Ni 110 ppm to 3000 ppm. The Au values ranges from <50 to 310 ppb

In Tamil Nadu, a G2 level exploration for Platinum group of elements (PGE) was carried out in T3 sector of Tasampalaiyam block in Sittampundi anorthosite complex. Chromitite/ chromiferousmetapyroxenite bands were the host of PGE and were seen occurring as detached lenses/boudins within anorthosite. The strike length of Segment-A and Segment-B of T3 sector is 550 m. The mineralisation in the area is confined to 04 nos. of chromitite / chromiferousmetapyroxenite bands. Drilling for first level (05 nos. borehole), second level (04 nos. boreholes) and third level one borehole was carried out at 50 m spacing in between the boreholes drilled during G-4 & G-3 stages as infilling to assess the PGE resource. Drilling in 9 boreholes intersected 4 mineralised

zones and development of ruby was noticed within the chromitite band. Besides, few minor bands were also intersected in the borehole. The thickness of the mineralized chromitite and meta-pyroxenite bands varies from 0.1 m to 1.22 m and from 0.1 m to 1.76 m, respectively. The investigation has proven the presence of mineralized band for a strike length of 500 m in segment A and B of T3 sector.

In Uttar Pradesh, G4 stage reconnaissance survey for PGE mineralization in GidwahaGirarPahar area, Lalitpur district involved mapping of 100.0 sq km area on 1:12,500 scale. Analytical result of Pt & Pd has shown values <5 and <10 ppb, respectively. Two channel samples of ultramafic rock collected from Bhikampur village showed Pt values of 10.7 ppb & 10.5 and Pd values of 6.3 & 5.7 ppb, respectively. Analytical results for base metal have shown value of Cr & Ni ranging from 17-4722 ppm & 3-2325 ppm, respectively. On integration of exploration data it was found that the ultramafic body mapped at Bhikampur village extend for a strike length of 1 km with width of about 125 m showed highest value of Chromium (2050-4722 ppm) and moderate anomaly of nickel (627-1525 ppm).

Directorate of Geology & Mining, Uttar Pradesh

Exploration work was taken up in search of PGE in around Pipariya, Ikauna area, Lalitpur district. The ultramafic/mafic rocks of Madaura-Ikauna-Pindar tract is the eastern extension of Madaura ultrabasic complex. A series of ultramafic rocks are randomly exposed as lensoidal intrusive discrete bodies in the form of isolated outcrops into the granite-gneisses around 20 km streched in Madaura-Ikauna-Pindar tract. The exploration work involved mapping of 20 sq km area on 1:12,500 scale, excavation of 167 cm m material in 4 trenches and collection of 16 samples.

Diamond/Kimberlite

GSI

In Andhra Pradesh, a G3 level preliminary exploration to assess diamond potential of Penna Ahobilam Kimberlite, Wajrakarur Kimberlite Field (WKF) in Ananthapur district was carried out. During the study, number of test pits were made on four sides of the pipe to demarcate the boundary of the pipe.The dimension to the pipe is measured 315 x 240 m. A total of 310 tons bulk samples was collected and processed. Diamond and other associated indicator minerals like pyrope garnet, picro-ilmenite, and chrome-diopside were recovered.A total 23 numbers of diamond (2.83ct) were recovered from the processing of 310 tons of kimberlite samples. The diamond grade of the pipe is estimated very low i.e.0.91 ct and was not recommended for further exploration. During the traverse taken in andaround Pipe-17, one Lamprophyre body (Dyke) of above 250 - 300 m length was discovered to the south of the Kimberlite pipe-5.

In Guntur district, a G4 stage survey in Piduguralla and Inumella areas of Krishna River basin comprised reconnaissance survey of around 750.0 sq km area on 1:50,000 scale. During survey, 150 stream sediment samples, 21 petrological samples and 05 each of petrochemical samples, XRD samples and SEM samples were collected. Analytical results showed suspected ilmenite grains hold 52.02 wt% TiO_2 and <0.01% MgO content.

In Kadapa district, during G4 stage reconnaissance survey for primary source rocks for diamond in Kamalapuram and Proddatur areas of Penneru River basin, around 750.0 sq km area on 1:50,000 scale was covered under reconnaissance survey and 153 stream sediment samples were collected from trap sites. Electro Probe Micro Analyser (EPMA) analytical results indicated that garnets recovered from the Cuddapah basin were from non - kimberlitic affinity as its MgO content was < 13% & Cr_2O_3 was also <1%. Most of the ilmenite grains collected from stream sediment samples were non-kimberlitic.

In Anantapur and Kurnool districts, a G4 stage reconnaissance survey of 740.0 sq km areaon 1:50,000 scale was taken up to locate primary source rocks for diamond in Yadiki and Nereducherla areas of Eastern Dharwar Craton. After integration of all available data, a possible target area of 120.0 sq km was identified and mapped on 1:25,000 scale.The analytical results of EPMA samples showed grossular composition (66 to 70%) for garnet grains where Al_2O_3 vary from 20 to 22 wt%, CaO 22 to 23 wt%. The suspected ilmenites were found to be consist of TiO_2 ranging from 31 to 49 wt%, FeO 5 to 46 wt%

and MnO from 0.04 to 2.07 wt% and they were non-kimberlitic confirmed by microprobe analysis.

In Jharkhand, during G4 stage reconnaissance survey for Kimberlite clan of rocks (KCR) in parts of Gumla and Simdega districts,a total of 151 nos. of stream sediments samples were collected from appropriate trap sites.During EPMA studies, 17 nos. of pyrope garnet and 02 nos. of picroilmenitewere identified in samples collected from Silam nala.Based on the recovery of kimberlite indicator minerals in Silam nala, detailed mapping of 3 sq km area on 1:4,000 scale was carried out near Silam village along with repeat stream sediment sampling from Silam nala.Closed spaced traverses revealed two lamprophyre bodies near Silam and Konderkela villages. The lamprophyre body near Silam is 12 m in length and 1.1 m in width and near Konderkelait has a strike length of about 60 m with width of 30 m.Presence of kimberlite indicator minerals and occurrences of lamprophyre bodies underlines possible occurrence of source rock ofthesemineralsviz. kimberlite/lamproite/lamprophyre in the upstream direction of Silam nala.

A G4 stage reconnaissance survey for Kimberlite clan of rocks was taken up in parts of Gumla, Lohardaga and Latehar districts of Jharkhand state. The EPMA study of suspected garnets of a stream sediment sample felt between almandine and spessartine.

During G4 stage reconnaissance survey for Kimberlites in the southern extension of the Wajrakarur Kimberlite Field, in the PGC terrain in parts of Tumkur district Karnataka and Anantapur district, Andhra Pradesh, a total of 700 sq km area was mapped on 1: 50,000 scale. The study area exposes rock types of Ramagiri Schist Belt, PGC II and younger granites of Archaean age intruded by Proterozoic mafic dykes. Amphibolite of older metamorphites is the oldest rock unit and occurs as enclaves within the gneisses and granite.

In Odisha, G4 stage reconnaissance survey for primary source rock for diamond was taken up around Karasingha-Diptipur-Larambha area, Bargarh and Bolangir districts. During study, a number of suspected grains of kimberlite indicator minerals were separated from heavy mineral concentrates and kept for confirmation for their kimberlitic affinity by EPMA, SEM and XRD studies.

In Telangana, G4 stage reconnaissance surveyfor primary source rocks of diamond was taken up in Thoodukurthy block, in parts of Wanaparthy and Nagarkurnool districts. The mineral chemistry of the suspected kimberlite indicator minerals from EPMAanalysis indicated that the garnet grains were low in Cr_2O_3 content, ilmenite grains showed low MgO content and falling in non-kimberlite fields.

A G4 stage reconnaissance survey for primary source rocks of diamond was taken up in Atmakur block, north of river Krishna, in parts of Mahabubnagar, JogulambaGadwal and Wanaparthy districts.The heavy mineral concentrates were scanned under stereo-binocular microscope for identifying kimberlite indicator minerals. Suspected kimberlite indicator minerals were analysed with EPMA and the analytical result for garnet, ilmenite (low MgO content), pyroxenes indicated that the mineral grains were of crustal origin.

In Madhya Pradesh and Uttar Pradesh, a G4 stage reconnaissance survey of Kimberlite/ Lamproite and secondary diamonds was taken up in Shahpur block in parts of Panna and Satna districts of Madhya Pradesh and Banda district of Uttar Pradesh. A total of 101 stream sediment samples were collected from appropriate trap sites. Heavy Mineral Concentrates (HMC), few suspected Kimberlite indicating minerals including garnets, spinels, chromites and ilmenites were identified which are yet to be confirmed though EPMA. During the search of diamond source rock, two ultramafic dykes were reported from Gudha Kalan. On the basis of petrological and geochemical studies, the altered ultramafic rocks show affinity towards lamprophyres. The dykes were seen vary in dimension from 2-4 m in length and 15-20 cm in width.

A G4 stage reconnaissance survey for kimberlite/ lamproite in Kalyanpur block was taken up in parts of Panna and Satna districts of Madhya Pradesh and Banda and Chitrakoot districts of Uttar Pradesh. A total 113 stream sediment samples were collected from appropriate trap sites. During heavy mineral separation (HMS), few suspected

Kimberlite indicator minerals including garnets, spinels, chromites and ilmenites were identified but yet to be confirmed though EPMA. During field traverses, variety of mafic/ultramafics/basic rocks were encountered in the study area. From the bipolar anomaly delineated from aeromagnetic anomalous map of OGP -02, 10.8 sq km area was identified. A total of 30 L. km geophysical magnetic survey with an interval of 350 m x 20 m was carried out in the study area. A hidden anomalous zone indicative of indirect clue of Kimberlite Clan Rocks (KCR) was demarcated. Based on detailed geophysical mapping and geological traverses in Singhpur block, it could be concluded that the area covered by Baghain sandstone with sporadic capping of laterite showed high magnetic anomaly. Based on study data, a vertically dipping cylinders, having diameter 100 to 500 m and having depth of 140 to 300 m mineral body was inferred.

MECL

In Andhra Pradesh, a G4 stage survey for Kimberlite Clan of Rocks (KCR) was carried out with an objectives to demarcate the Kimberlite clan diamond bearing formation, collect stream sediments samples,estimate resources, etc. in Kalyandurg-Timmasumudram block, Anantpur district. Area of 1172.00 sq.km was mapped on 1:12,500 scale and collected a total of 44 samples including 40 stream sediments samples.

Precious Minerals

Gold

The GSI, HGML and DGM, UP were engaged in the exploration for gold during 2019-20. An account of exploration work done by GSI is detailed in Table-7.

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 0.1 sq.km area on 1:2,000 scale, excavation of 50 cu. m through 2 trenches each of dimension 25 m x 1 m x 1 m, and collection of 40 chemical samples for chemical analysis. In Berwar area, Lalitpur district, search for placer gold was continued by geological mapping of 0.3 km^2 on 1:2,000 scale alonwith geophysical magnetic survey of 0.16 sq km . About 88 m^3 material has been excavated in three trenches and a pitting of dimension 1 m x 1 m x 1 m was also carried out in the area and collected 103 samples 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 carried out exploration work in Hira-Buddinni Gold Mine, Village Hutti, Lingasugur taluka, Raichur district was taken up with an objective to explore the strike and depth continuity of existing reefs, presence/absence of footwall or hanging wall branches of the existing reefs and existence of any blind shoots.About 64.90 m of on-lode development work was carried out alongwith collection of 410 samples. The total estimated quantity of resources as on 01.04.2020 is about 0.33 million tonnes of ore with average grade of 3.10 g/t of metal including 0.68 million tonnes of ore with average grade of 3.62 g/t of metal under reserve category. In Uti Gold Mine, Village Uti, Deodurga taluka, Raichur district, exploration work could not be taken up due to local issues. The total quantity of resources as on 01.04.2020 estimated in the mine is about 3.42 million tonnes of ore with average grade of 2.18 g/t of metal including 0.50 million tonnes of ore with average grade of 2.20 g/t of metal under reserve category. In Hutti Gold Mine, Village Hutti, Lingasugur taluka exploration was taken up with an objective to explore the strike and depth continuity of existing reefs, presence/absence of footwall or hanging wall branches of the existing reefs and existence of any blind shoots. Exploration work comprised drilling of 12 boreholes to a total depth of 619.00 m, collection of 10,788 samples and 3,396 m of on-lode development work in the mine. The estimated total resources in the mine is about 24.22 million tonnes of ore.

Industrial Minerals

The details of exploration carried out for

Table - 7: Exploration for Gold by GSI, 2019-20

State/District	Location	Details of work done	Results obtained/Remarks
Arunachal Pradesh			
Lower Subansiri	Phop area	Mapping & Drilling	During preliminary exploration for gold, molybdenum, vanadium and associated minerals, detailed mapping over an area of 1.0 sq km on 1:2000 scale and systematic drilling was carried out in the study area. The banded magnetite quartzite and carbonaceous phyllite was targeted for gold, vanadium and molybdenum mineralization, respectively. Banded magnetite quartzite in the area is extended for about 400 m with width of the band varies from 6 m in the east to 17 m in the west. Zone of sulphide mineralization was intersected from 51 m to 59 m along the length of the borehole. Out of the four carbonaceous phyllite bands mapped in area, the southern band is consistent and extends for a strike length of 250 m with width of the band varies from 10 m in the east to 17 m in the west.
Bihar			
West Champaran	Foothills of Siwalik Himalayas	Mapping & Sampling	Reconnaissance survey was taken up in search of placer gold in the foothills of Siwalik Himalayas involving large scale mapping of 100.0 sq km. Panning of samples have shown presence of fine gold flakes/grains (10-100 nos.) and gold dust in the pan concentrates of stream sediment, colluvial, and pit samples. Analytical results of pan concentrates of orientation samples for different size fraction viz., <2 mm to +60 mesh size, -60 to +80 mesh size, -80 to +100 mesh size and -100 mesh size showed Au value ranging from 0.07 to 2.41 ppm, 0.07 to 0.35 ppm, 0.13 to 1.83 ppm and 0.17 to 30 ppm, respectively. Heavy mineral study of the pan concentrates showed presence of garnet, sillimanite, kyanite, magnetite, ilmenite, pyrite, rutile, tourmaline, zircon, apatite, and monazite.
Chhattisgarh			
Mahasamund	Chanat-Jogidadar areas	Mapping & Sampling	During reconnaissance survey for gold and associated sulphide mineralization in study areas, an area of 100.0 sq km was mapped on 1:12,500 scale along with 50 cu m pitting/trenching. From first order river, 8 stream sediments samples were collected, panned and a total of 10 to 12 gold grains were recovered. In the studied sample, native gold was associated with arsenopyrite, molybdenite, chalcopyrite and pyrite. Au analysis of two samples from sheared mineralized quartz vein showed maximum value of 0.2-0.4 g/t. A two metre zone was demarcated by trench, wherein value of Au ranges from 0.07 g/t to 0.2 g/t.
Baloda Bazar & Mahasamund	Bhogdih - Junadih areas	Mapping & Sampling	Reconnaissance survey for gold and associated sulphide mineralization was taken up involving large scale mapping 50.0 sq km on 1:12,500 scale. Manifestations of disseminated sulphides like chalcopyrite, pyrite and galena were noticed in

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Table - 7 (Contd)

State/District	Location	Details of work done	Results obtained/Remarks
			quartz veins occurring at the contacts of metarhyolite and metabasalt as well as metarhyolite and gabbro near Bilari, Kesharpur and Rangmatiya villages. Silt size gold grains were recovered from sediments collected from 1st and 2nd order streams in the north-eastern part of the area around Rangmatiya village. An oxidised quartz vein extending for about 40 m was delineated occurring at the contact of rhyolite and metabasalt and sample collected this quartz vein was analysed and yielded 0.6 g/t gold.
Jharkhand			
East Singhbhum	Bana, Bisrampur, Morchagora, Bagmara areas	Mapping & Sampling	During reconnaissance survey for gold and associated minerals, an area of 61.7 km^2 area encompassing Bhitar Dari-Morchegora-Baghmara area (eastern block) and 38.3 km^2 area around Dubrajpur-Bana area (western block) was mapped on 1:12,500 scale. The evidence of mineralization is observed in form of boxworks, pits and vugs on the smoky quartz veins and quartzite/cherty quartzite, malachite stain, goethite-limonite alteration and presence of sulfides (pyrite, chalcopyrite) along the thin veinlets in quartzite in the eastern block and as dissemination within metabasic rocks in the western block. At the east of Kero village, visible gold grains were reported in pan concentrates of stream sediment sample. Based on the surface indication of mineralisation, the mineralised host rock i.e., tuffaceous phyllite exposed in Bhitar Dari also extend in the study area.
	Astakowali-Chakri block	Mapping & Sampling	During reconnaissance survey for gold and associated minerals in the area, large scale mapping was carried out on 1:12,500 scale. Sulphide mineralization in the form of pyrite, chalcopyrite, arsenopyrite were observed in ultramafic rocks near Kitamahali, Hatikocha, Kantashol area and in shear zone in quartzite/ quartz vein near Poradiha area. Gold specks were seen in four pan concentrates. Chemical analysis of samples revealed maximum gold value of 0.14 ppm. Chemical analysis of REE indicated encouraging values of total REE ranging from 908.55 to 2108.46 ppm near Uparbera area.
Ranchi and Saraikela-Kharswan	Ichagarh -Tiruldih areas	Mapping & Sampling	A reconnaissance survey for gold and associated minerals involved large scale mapping of 100 sq km area on 1:12,500 scale. One major shear zone is identified in the northern part of the area extending for over 15 km from Chogadih in the west to Burathakur Pahar in the east. The mineralized zone is traced further eastward near Baruna Ratai where visible sulphide is present (pyrite, chalcopyrite and bornite). Besides, two other shear zones were marked in the area i.e. one extends from Chota Amra in the west to Gaurangkocha in the east and other running south

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Table - 7 (Contd)

State/District	Location	Details of work done	Results obtained/Remarks
			west of Hutup in NW-SE direction . Stream sediment samples from streams draining the shear zones yielded visible gold flakes. Stream sediments samples (6 nos.) contained visible gold. The value of Cu ranges from 5-800 ppm; Pb ranges from 5-57 ppm and Zn ranges from 6-230 ppm . Based on field indications, the Hutup block, Baruna Ratai block, Chogadih block and the Burathakur block looks promising.
West Singhbhum	Kotiya-Kamrora areas	Mapping & Sampling	Reconnaissance survey for Au-Cu-Zn was taken in the survey area. Numerous quartz veins of both milky and smoky variety cross cut through the metabasic rocks as well as in the micaschists. The smoky quartz vein contains specks of chalcopyrite at few places. The chemical data of metabasalts showed Cu value ranges from 169 to 260 ppm, Zn 65 to 88 ppm. The smoky quartz vein showed Cu and Zn value of 33 to 169 ppm and 24 to 233 ppm, respectively. The Cu content in mica schist varies from 95 to 112 ppm. The Vanadium and Fe_2O_3 (T) content in laterite ranges from 616 to 1392 ppm and 28.91% to 55.20%, respectively.
	Tobo and Ragto areas	Mapping & Sampling	Reconnaissance survey for gold, copper and zinc in the area involved large scale mapping of 100 sq. km area on 1:12,500 scale. Massive hard and compact bluish quartz-biotite schist with garnetiferous patches and elongated volcanic clasts at places is the main lithounit identified as the potential one for Au-Zn-Cu mineralization. Malachite and Azurite stains and visible chalcopyrite, bornite minerals were identified in this unit. The exposure of this mineralized zone in Bharandiya area is about 35 m long with thickness more than 15 m. the Chemical results indicated maximum Au value of 2ppm, Cu value ranges from 0.41% to 1.25% in the samples of this unit. At North of Gojaburu hill, four old workings of base metals and boulders of quartz veins containing chalcopyrite and malachite stains has been reported.
Karnataka			
Chitradurga	Lakkavanahalli block	Mapping & Sampling	During preliminary exploration for gold in Lakkavanahalli block, detailed mapping on 1:1,000 scale, pitting, trenching and sampling along with 20 L.km of ground geophysical survey including magnetic, resistivity and IP were carried out to delineate concealed BIF bands in the area. Auriferous BIF band having a strike length of 600 m with variable thickness ranging up to 7 m was demarcated. Available analytical results indicated the average Au values to be 0.50 g/t x 5.4 m, 0.36 g/t x 6 m, 1.15 g/t x 1 m, 0.41 g/t x 2 m and 0.68 g/t x 1 m from trench nos-9, 10, 13, 14 and 15, respectively.

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Table - 7 (Contd)

State/District	Location	Details of work done	Results obtained/Remarks
	Kallenahalli block	Mapping, Trenching, Drilling & Sampling	During preliminary exploration for gold in Kallenahalli block, an area of about 1.74 sq km was mapped on 1:1000 scale and drilling of 782.4 m was completed in 6 boreholes. Sulphide mineralization present in the form of dissemination along the foliation and also in form of veins and patches at places in the altered meta-basalt. Bedrock samples yielded Au value of 60 ppb to 433 ppb. Chemical results of borehole-1 samples established two zones i.e. Zone-1 from 125.36-129.49 m with 0.2 ppm average grade and Zone-2 from 133.84-138.95 m with 0.26 ppm average grade. The true thickness of the Z-1 and Z-2 was reported 3.17 m and 4.34 m, respectively. In borehole-2, the maximum Au value analyzed was 375 ppb. Cu has highest value of 400 ppm from 96.6 to 97.1 m.
	Ramajogihalli area	Mapping & Sampling	During reconnaissance survey for gold and associated elements in Ramajogihalli area, detailed mapping of 0.6 sq km area around quartz vein QV-4 was carried out on1:1000 scale. Chemical and analytical data showed that Au values range from 38 ppb to 1.49 ppm. Copper contents in most of the samples range between 15 to 140 ppm. Three bedrock samples were analysed for Zn, Ni and Co values which range from 60 to 75 ppm, 80 to 135 ppm and 15 to 25 ppm, respectively.
Haveri	Near Devargudda	Drilling & Sampling	Preliminary exploration for gold was carried out near Devargudda area. Mineralization is mainly controlled by remobilized hydrothermal veins of few mm to few cm thicknesses. Sulphide-Au mineralization showed a close spatial relationship to zones of intense alteration. A total 4 boreholes were drilled to a cumulative depth of 455.0 m in the study area. Result of 39 BRS samples yielded positive Au values.
Gulbarga	Jainapur block	Mapping, Drilling & Sampling	Preliminary exploration for gold mineralization in Jainapur block, Manglur schist belt comprised detailed mapping of 1.50 sq km on 1:1,000 scale, trenching of 140 cu. m and of 850.80 m drilling in 8 boreholes. The host rock containing gold mineralization in the study area is generally fine grained sheared amphibolite. In bedrock samples, gold value is reported up to 34 ppb. Two gold mineralized zones were established in a trench. The thickness of Au mineralized zone-I is 5 m with an average value of 1.1 ppm and Au mineralized zone-II thickness is 3 m with an average value of 0.15 ppm. In a borehole two Au mineralized zones were intersected. The gold mineralized zone-I thickness is 5 m with an average value of 0.05 ppm Au. The gold mineralized zone-II thickness is 7.5 m with an average value of 0.53 ppm of Au.

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State/District	Location	Details of work done	Results obtained/Remarks
Davangere	Honnamardi block	Drilling & Sampling	During preliminary exploration for gold in study block, exploratory drilling was carried out to fill the gap areas and to check the continuity of the mineralized Honnamardi lode at deeper level. A total of 868.47 m of drilling was carried out in 5 boreholes. Total 188 core samples were sent to chemical analysis for gold. Analytical result of 117 samples showed discouraging values of gold.
Bagalkot	Yalligutti and Mughlalli block	Sampling	Reconnaissance survey for gold and associated metals was taken in Yalligutti and Mughlalli block. Nine bedrock samples from Banded Magnetite/ Haematite Chert bands have shown anomalous Au values up to 336 ppb. Trench samples near the zones have yielded anomalous Cu (345 ppm max), Cr (1575 ppm max), Ni (338 ppm max) and Zn (120 ppm max) values. Surface manifestations of possible auriferous zones are marked by vein filling sulphides/ oxides (pyrite, chalcopyrite, bornite) and as secondary minerals pyrite, chalcopyrite, limonite and goethite.
Madhya Pradesh			
Jabalpur	Chargwan-Hinota area	Mapping	Reconnaissance survey for gold and associated elements comprised large scale mapping on 1:12,500 scale over an area of 100.0 sq km. Mineralization in the area is marked by the presence of sulphide minerals such as pyrite, arsenopyrite and chalcopyrite present as disseminations and fracture-fillings, respectively in quartz veins, BHQ and garnet-mica schist. In Maramao area, specks of arsenopyrite and pyrite were noticed within 3 m thick smoky quartz veins and BHQ. Similarly, in the south of Jamuniya, strings of pyrite and chalcopyrite were observed within white-coloured quartz vein. During trenching in Semra area, specks of pyrite were noticed within garnet-mica schist.
Odisha			
Angul	Mankarhachua Area	Mapping & Sampling	During reconnaissance survey for search of gold and associated elements, an area of 110.0 sq km area was mapped on 1:12,500 scale. A total of 11 intraformational Quartz Pebble Conglomerate (QPC) bands were delineated on southern slopes of the Mankarhachua and Dharamduar Parbats. Almost all the QPC bands contain disseminated sulphide specks; however, three bands are rich in sulphide mineralisation. These three sulphides bearing horizons were traced discontinuously for a cumulative strike length of 3.1 km with maximum width of around 60 m. Another sulphide zone was delineated in Malangtoli metabasalt for a strike length of 2.7 km with width of 375 m in the northern slope of Mankarhachua and Dharamduar hills. Gold grains were recorded in the panned samples from streams draining both QPC and metabasalt, which suggested direct evidence of gold mineralisation in the study area.

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Table - 7 (Contd)

State/District	Location	Details of work done	Results obtained/Remarks
			Grab samples yielded values of 94 ppb, 120 ppb, 400 ppb and 19 ppm.
	South of Pal Lahara area	Mapping	Reconnaissance survey for search of gold and associated elements in the area involved large scale mapping of 100.0 sq km area on 1:12,500 scale. During the investigation, four sulphide mineralization zones were delineated in the area. In Zone 1- Malayagiri Parbat (north of Baliposi village), the sulphide mineralization was noticed in amygdular metabasalt traversed by fine quartz and quartz carbonate veins having strike length of 125 m and width of 36 m. In Zone 2- Malayagiri Parbat (north of Sukhadebapur village), the sulphide mineralization was seen in amygdular metabasalt traversed by fine quartz and quartz carbonate veins having cumulative strike length of 162.5 m and width is 22 m. In Zone 3-Tirbi village, the sulphide mineralization was noticed in metabasalt traversed by quartz veins and fine carbonate veins having cumulative strike length of 150 m and width is 18 m. In Zone 4-Bagadari village, the sulphide mineralization zone was seen in deformed granite gneiss traversed by quartz veins having strike length of 187.5 m and width is 24 m.
Mayurbhanj	Luhashila blocks	Mapping & Trenching	Reconnaissance survey for gold in Surda-Ruansi and Luhashila blocks of Badampahar - Gorumahisani belt was taken up. Large scale mapping on 1:12,500 scale was carried out in 65 sq km area. Surface indication of mineralisation in the area is seen in the form of presence of old-workings, sulphide disseminations, silicification, ferruginisation and carbonatisation. Two potential areas for gold mineralization were demarcated in the Surda-Ruansi block i.e. (i) Dublabera in the western part of the block was delineated upto a strike length of 600 m by trenching and (ii) Suriagora area in the north eastern part of the block extend for 500 m length with 50 m width was delineated with two old gold workings. Visible gold flakes were noticed during panning of soil samples collected from the old workings and sediment from nearby stream.
Jharkhand & Odisha			
East Singhbhum & Mayurbhanj	Dhengam-Phuljhari block	-	During reconnaissance survey for gold and associated minerals in the area, sulphide bearing (pyrite, chalcopyrite) massive, amygdaloidal meta-basalt were noticed in and around Dublabera, Kendua, Burlukola and Nimdiha of East Singhbhum district. Meta-basalt contains mainly pyrite and chalcopyrite in and around Birugora. Sulphide bearing gabbro was observed at south of Dhengam. Sulphide (pyrite, chalcopyrite and pyrrhotite) bearing ultramafic was reported at south of Tupaghutu, south of Kumarkocha, in the east of Mankargora Parbat and in and around Lakhaidih.

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Table - 7 (Contd)

State/District	Location	Details of work done	Results obtained/Remarks
			White quartz vein contains sulphide along fractures was at west of Kendua. Sulphide mineralisation is also observed in the smoky quartz vein as well as in grey coloured, very fine-grained quartz vein in and around Chirubera, Bongadungri and Sindurpur, close to Kunderkocha gold mine.
	Netotiril-Sana Siajang -Jojodih area	Mapping & Sampling	Reconnaissance survey for gold and associated minerals in the area involved mapping of 100.0 sq km on 1:12,500 scale. Near Siddadih, a 750 m long intense zone of brecciation and secondary silicification has been identified to be potential zone due to presence of well developed boxwork features. Chemical analyses result of 61 bedrock samples showed Cu value ranges from 5 to 350 ppm, Pb 5 to 75 ppm and Zn 5 to 450 ppm. Smoky quartz vein reported 380 ppm and 220 ppm Zn from near Ragabdih. Trace element concentration of whole rock revealed 6694 ppm Cr and 1218 ppm Ni in meta-ultrmafite and 1209 ppm of Cr and 484 ppm of Ni in fuchsite quartzite near Satpur. Chlorite schist/metabasic rock depicted 465 ppm of barium and 697 ppm of strontium.
Rajasthan			
Udaipur	Navagaon Bhanor-Dhuntamagra area	Mapping, Trenching & Sampling	Reconnaissance survey was taken up in search of gold and base metal mineralization in the area. A total of 100.0 sq km was mapped by large scale mapping. On the basis of the surface evidences of mineralisation, two mineralised zones were delineated. Zone-1 mineralisation was delineated on the basis of gossan present in Devgaon area. This zone has a dimension of 800 m in length and 30-40 m in thickness and Zone-2 delineated on the basis of abundant malachite stain and visible specks of chalcopyrite and covellite present in the Bhanor, Dholagarh and Dholiyakakad area. The Zone-2 is roughly 1.5 km in length and 50 m in thickness. Anomalous values of Cu in 82 bed rock samples vary from 5 ppm to 0.1% with average value of 0.48%. In the mineralized zone (MZ-1), anomalous values of Au ranging from 0.05 to 1.78 ppm and an average of 0.370 ppm were recorded in 32 bed rock samples.
	Kanpura-Bara Kunda areas	Mapping, Trenching & Sampling	Reconnaissance survey was taken up for gold and base metal mineralization in the study area. The surface indications of mineralisation were observed in the form of malachite stains, gossan, silicification and presence of sulphide specks. The gossan zones are mostly associated with quartzite as near Waliakhera, Kadma and Anjeni. The zone of mineralization was noticed near the hinge of the fold and along sheared contact zone and seems to be of secondary origin associated with quartz veins. The Cu values more than 1% is attributed to the samples from near rich gossan zones as near waliakhera, Bara-Ghagri and old working near

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Table - 7 (Contd)

State/District	Location	Details of work done	Results obtained/Remarks
			Kangra and, Anjeni. The spot bedrock samples from wall rock of old working near south of Anjeni yielded highest value 2.29% for Cu. Based on the available analytical data south of Anjeni and Kangra area are identified as potential zones.
Banswara	Undwala -Padi Ka Khera blocks	Sampling	During preliminary exploration for gold and associated base metal mineralization, three zones in Undwala block and two in Padi Ka Khera block in ferruginised/gossanised zones were identified and demarcated. Occurrences of mineralization noticed in the form of pyrite, chalcopyrite, etc were reported mainly in white and pink marble in the southeastern part of the Undwala block. A total of 202 channel samples were collected from 08 channels laid across the five mineralization zones. The analytical results of these samples indicated gold from <0.05 ppm (except in two samples having 1.0 and 0.15 ppm gold), copper values 25 to 570 ppm and lead values < 25 ppm in all the samples, Zinc values 20 to 781 ppm, Nickel values 50 to 710 ppm, Cobalt values 40 to 640 ppm. Silver values in all the samples were <5 ppm.
-	Jagpura north	Sampling	Preliminary exploration was taken up for gold and associated base metal mineralization in the area. The occurrence of mineralization was manifested on the surface by a number of parallel to sub parallel and discontinuous bands of gossan, malachite/azurite stains, pyrite, etc. Two mineralized zones (MZ-I and MZ-II) have been delineated. MZ-I is around 4-30 m width and around 500-600 m in strike length while MZ-II is arond 2-8 mm in width and around 40-50 m in strike length. Available results of channel samples indicated good surface value of copper and gold. Analytical results of 29 bed rock samples yielded 0.39% of average Cu and 3.69 gm/ton of gold value. One random bed rock sample showed 15.9 g/t gold.
Tamil Nadu			
Tiruvanamalai	Neerpathurai-Rajapalayam and Kattamadavu areas	Mapping & Sampling	During reconnaissance survey for gold and associated mineralization in and around Neerpathurai-Rajapalayam and Kattamadavu areas, large scale mapping on 1:12,500 scale was carried out in the area. Stream sediment panning samples yielded 20 to 55 nos. of gold specks (<0.5 mm). About 70 to 100 nos of gold specks (<0.5 mm) and very fine gold dust were recovered from both the in-situ soil samples and termite mound samples. This has indicated the source rock for gold mineralization in two different parts (North West and Eastern part) of the exploratory block.

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Table - 7 (Concld)

State/District	Location	Details of work done	Results obtained/Remarks
Telangana			
Jogulamba Gadwal	Dharur-Dornala block	Sampling	Reconnaissance survey was taken up for search of Gold in parts of Gadwal schist belt and possible tungsten, REE and RM mineralization in associated pegmatite, etc. Quartz carbonate veins have altered the meta-basalt and have disseminated specks of arsenopyrite, pyrite etc. The analytical results received so far for gold and REE, in general were not encouraging.
Jogulamba Gadwal & Wanaparthy	Atkur area	Sampling	Reconnaissance survey for the search of gold and possible REE, tin and tungsten mineralisation was taken up in Gadwal schist belt and associated pegmatite. Surface manifestation of mineralization is observed in the form of sulphide mineralization such as pyrite, pyrrhotite, chalcopyrite, bornite, stains of malachite, and alteration zones. The analyses of 78 bedrock samples for gold value did not yield encouraging value. However, 2 stream sediment samples yielded 15.02 ppm and 2.66 ppm gold value. There are number of pegmatite veins which were sampled for REE, tin, tungsten analysis.
Uttar Pradesh			
Sonbhadra	Dala- Roopadandi areas	Sampling	Reconnaissance survey was taken up to locate placer gold and diamond in the study area. Conglomerate body has been traced from Dala to Roopadandi, the strike length of the conglomerate is approximately 13 km and width of the body varies from 10-20 m. The conglomerate body traced in Hardi area has attained a width of 30-70 m with approximately 4.5 km strike length. As per the available chemical results, gold values were <50 ppb and base metal & other elements showed low values while Mn showed values between 06 to 2884 ppm.
West Bengal			
Bankura	Ambikapur-Ranibandh-Porapahar area	Mapping & Sampling	During reconnaissance survey in the area for gold, an area of 100.0 sq km was mapped in 1:12500 scales. Two potential target zones i.e. Tepra zone and Narayanpur-Kheriyakocha Zone for further search was demarcated on the basis of mapping, recovery of grains and flakes of gold from pan concentrate of stream sediments, etc and limited analytical results. In Tepra zone, acid volcanic rocks are highly sulfidized, containing specks and stringers of pyrite, chalcopyrite and profuse arsenopyrite. They are mainly observed in strata bound quartz-carbonate (ankerite) veins and are manifested by distinct sulphide staining The analytical results of pan concentrate from this Tepra zone have showed a gold value ranging from 10 to 22 ppm and gold value in pan concentrate of stream sediments in Narayanpur-Kheriyakocha zone ranges in between 22-23 ppm.

Table - 8: Exploration for Industrial Minerals by GSI, DMG/DGM, MECL, etc 2019-20

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		Reserves/resources estimated
GSI							
Linestone							
Assam							
Dima Hasao	North Boro Hundong block	1:4000	4	8	-	-	A G3 stage preliminary exploration for limestone in north Boro Hundong block was carried out with an objective to assess the potentiality of different grades of limestone and augmentation of resource. All the planned 08 boreholes at G3 stage of exploration were drilled vertically, intersected limestone and were closed at the depths ranging from 42 m to 130 m, respectively. Analytical results of 57 core samples of the limestone showed the value of CaO ranges from 37.14% to 50.86%, SiO_2 from 4.25% to 13.55% and MgO from 1.39% to 2.27%.
Dima Hasao	South Boro Hundong block	1:4000	4	4	390.0 m	-	A G3 stage preliminary exploration was carried out for limestone in the study area. Based on the drilling carried out in four boreholes in south Boro Hundong block, it was observed that the thickness of the Upper Sylhet limestone varies from 44.30 to 115.30 m with an average thickness of 84.89 m. The average overburden thickness in the area is 10.14 m. Chemical results of limestone zone showed CaO value ranges from 38.02 to 50.73% (average 44.75%) and the average values of MgO, SiO_2, Al_2O_3 and Fe_2O_3 were 1.71%, 7.56%, 3.75% and 2.31%, respectively. The study is continued.
Chhattisgarh							
Durg	Mohrenga-Kandai block	1:4000	5.6	35	2065.55 m	1480	A G3 level exploration for limestone was carried out by drilling boreholes up to a depth varying from 37.3 m to 91.55 m on 400 m X 400 m grid pattern. The limestone is stromatolitic, hard, compact and massive in nature and pink to dark grey in color. Partial analytical results received of 660 nos. of core samples showed CaO maximum upto 44.39% and delineated 3781 m x 736 m of the limestone zone the study area.

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Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
	Dani Kokri block	1:4000	1.69	02	100.0	-	During G2 level general exploration for limestone, an area of 1.69 sq km out of 4.48 sq km was covered by detailed mapping. The chemical analysis results of core samples showed CaO, MgO, SiO_2 and P_2O_5 ranging from 33.94% to 49.07% with an average 42.9%, 0.93% to 3.82% with an average 1.72%, 8.83% to 23.08% with an average 14.58% and P_2O_5 0.02% to 0.05% with an average P_2O_5 0.03%, respectively.
Raigarh	Amlipali block	1:4000	4.0	25	-	-	A G2 level general exploration for limestone was carried out with an objective to assess the limestone resource in the area. Boreholes were drilled in grid pattern at an interval of 400 m with average depth of 50 m. Analytical results of core samples from limestone zones yielded CaO from 34.05% to 48.74%.
Gujarat							
Junagadh	Jujarpur block Mangrol taluka	1:4000	5.76	36	794.5	-	During G2 level general exploration of limestone suitable for Steel Melting Shop (SMS), Cement grade and BF in the in the area, mapping along with fixing of boreholes at 400 m X 400 m grid interval were completed. Borehole were drilled up to the depth of 20 to 50 m below ground level. In the eastern part of the study area, in between limestone, there is thick litho-unit of calcareous soil and mud as compared to western side of the block.
Gir-Somnath	Chamoda-Tantivela block	1:4000	5.6	-	-	-	During G3 level preliminary exploration of limestone suitable for (SMS)/ Cement grade and BF in the limestone of Chamoda-Tantivela block of Patan-Veraval Taluka, 35 nos. of proposed boreholes were marked at 400 m grid interval. Eight samples of limestone of Miliolite Formations revealed average CaO 48.07% with minimum 44.69% & maximum 53.41%. During the course of drilling it was observed that average thickness of limestone is of 17 m. The Gaj

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Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							Formation is mainly composed of deep ochrous marly limestone, Dark grey calcareous clay and grey fossiliferous limestone. The calcareous conglomerate/gravels bed of 1.5 m thick encountered at the contact between Miliolite Formation and Dwarka Formation. A total 200 m drilling was carried out.
Karnataka							
Gulbarga	NE of Chamnur	1:4000	4.8	07	351.60	-	A G2 level general exploration for limestone resources was carried out in the study area. The target lithology was stylolitic limestone which proved to be of higher grade in terms of applications in Cement as well as steel industries. The litho-unit exposed in the area was mainly grey coloured limestone and the exposures were very scarce. It was observed that the thickness of the BF grade limestone is about 30 m in the block, with an overburden of blendable/ beneficiable cement grade limestone. The overburden to limestone ratio in the available intersections varies from 1:1.4 to 1:8 in case of the BF grade limestone.
Meghalaya							
East Jaintia hills	Lamarsiang block	1:4000	3.0	09	957.45	-	A G2 level general exploration for limestone in Lamarsiang block, Litang valley was carried out. A horizon of 15-20 m thick nummulites rich acme zone was observed in all the boreholes. Based on the chemical analysis results of borehole core samples, the limestone is of cement (Portland and Blendable) and SMS (OH) grades.
	Khaidong-Shnongrim block	1:4000	2.5	10	1250.03	491	A G2 level general exploration for limestone in Khaidong-Shnongrim block, Litang valley was carried out. The Upper Sylhet limestone was the target horizon for exploration which has thickness varying from 43.1m to 127.58 m with an average thickness of 99.53 m. The CaO, MgO and SiO_2 varies from 27.1 to 53.92%, 0.88 to

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							7.17% and 0.22 to 17.34%, respectively. The limestone is of Cement (Portland and Blendable) and SMS (OH) grades. The total resource of limestone over an area of 1.69 sq km in Khaidong-Shnongrim block estimated at about 359.35 million tonnes which included 52.89 million tonnes of Cement (Blendable/ Beneficiable) grade, 164.09 million tonnes of Cement Portland grade and 142.35 million tonnes of SMS (OH) grade.
	South-West of Mynthlu block	1:4000	-	-	628.6	-	A G2 level general exploration for limestone in south-west of Mynthlu block, Litang valley was carried out with an objective to assess the potentiality of different grades of limestone in the study area. The analytical results yielded CaO value between 30% and 48.35% and MgO between 3.30 and 0.98% and SiO_2 from 14.95 to 4.17%. The limestone falls in cement portland grade, cement blendable grade and beneficiable grade.
Rajasthan							
Jaisalmer	Khuiala South block	-	-	20	792	34	A G3 level preliminary exploration for SMS/cement grade limestone was carried out in the area under study. Subsurface data of boreholes reveal that mainly three types of limestone intersected in the boreholes i.e, hard and compact limestone, chalky limestone and clayey limestone. The cumulative intersected thickness of hard and compact, low silica Khuiala limestone, chalky limestone and clayey limestone in individual borehole ranges from 0.50 to 14 m within the depth range of 0 to 14 m, 2 to 6.62 m within the depth range of 5 to 12.36 m and 0.70 to 19.80 m within the depth range of 3.50 to 48 m, respectively.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
	Nibh Dungar area	1:12500	50.0	10	465	-	During G4 stage reconnaissance survey for low silica SMS/cement grade limestone, large scale mapping of area, various types of sampling and 50 cubic meter of trenching were carried out in the area. Scout boreholes were drilled within the depth range of 30 m to 50 m. Hard and compact, low silica limestone unit was intersected in 6 boreholes within the depth range of 0 m to 3.75 m. Limestone interbedded with clay was intersected in 9 boreholes having average width of 15 to 18 m and is mainly recorded in the top and the lower part of the borehole.
	Lakhmanon Ki Basti block	1:4000	4.60	17	604.0	-	A G3 level preliminary exploration for low silica SMS/ cement grade limestone was carried out in the area. Boreholes were drilled up to a depth of 40±10 m on grid pattern with borehole spacing of 400 m. The cumulative intersected thickness of hard and compact limestone of Khuiala Formation in borehole ranges from 1 m to 15.85 m within the depth range of 0.5 m to 44 m. The cumulative intersected thickness of chalky limestone in borehole ranges from 0.65 m to 1.10 m with depth of intersection from 16.35 m to 19 m. The cumulative intersected thickness of clayey limestone in borehole ranged from 0.15 m to 07.45 m with depth of intersection from 4 m to 46 m. The cumulative intersected thickness of foraminiferal limestone intersected in borehole ranges from 0.30 to 1.60 m within the depth range of 8.90 m to 44.45 m.
Tamil Nadu							
Tiruchirapalli and Karur	Muthampatti block	1:12500	107	-	-	-	A G4 stage reconnaissance survey for cement grade limestone was carried out comprising large scale mapping and trenching of 200 cu m. Four major bands of limestone were identified in the area i.e. Band A: The limestone band was delineated for a cumulative strike length of about 7 km, occurring

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							as continuous body from Mamarrattuppatti in the west to Ayyampalayam in the east with outcrop width of about ~50 to 350 m. The chemical analysis showed CaO ranging from 42.58 to 52.94%; Band B: Pink and white crystalline limestone band of strike length 2.5 km with width of about 70 to 170 m. The average grade of this limestone band is 51.18%; Band C: Pink and white crystalline limestone band of 3 km strike length with width of about 70-180 m. The average grade of this limestone band is 51.78%, and Band D: White and pink crystalline limestone intercalated with calc granulite to a strike length of about 3-3.5 km with width of about 10 to 30 m. The average grade of this limestone band is 51.81%.
Madurai & Sivaganga and Thiruchirappalli & Karur	Piranmalai & Viralipatti area	1:12500	130	-	-	-	During G4 stage reconnaissance survey for limestone in Piranmalai area of Madurai & Sivaganga districts, and Viralipatti area of Thiruchirappalli & Karur districts, large scale mapping and pitting / trenching of 260 cu.m was carried out. The analytical values of CaO and MgO for 91 bedrock and pitting/trenching samples of calc granulites from Piranmalai area range from 1.51-18% and 0.58 to 8.65%, respectively.
Telangana							
Khammam and Bhadradri-Kothagudem	Manikaram block	1:12500	100.0	-	-	83	A G4 stage reconnaissance survey for flux grade dolomitic limestone and associated sulphide mineralization was carried out in Manikaram block, in parts of Khammam and Bhadradri-Kothagudem districts. The investigation was taken up based on the presence of limestone band having maximum width of 1.5 km near Motlagudem village and occurrence reported of old workings of sulphide mineralization in the east of Manikaram village. The results of bed rock samples showed CaO+MgO values more than 45%

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							with silica less than 7%. The analytical results of BRS samples indicate that the area is having good quality of dolomitic limestone and are of flux grade.
Uttarakhand							
Pithoragarh	Chaunala and Pabhen blocks	1:4000	2.5	2	189.0	-	A G2 level general exploration for limestone around Chaunala and Pabhen blocks in Agalgarhdhar area was carried out. Bedrock and channel samples were collected from the limestone body for chemical analyses. Results of geochemical analysis of bedrock samples revealed CaO, MgO, Al_2O_3, Fe_2O_3 and SiO_2 ranging from 25.55% to 51.43% (avg. 43.13%), 0.98% to 16.76% (avg 3.75%), 0.1% to 0.82% (avg. 0.58%), 0.11% to 0.69% (avg. 0.227%) and 1.35% to 24.51% (avg. 13.92%), respectively.
Pithoragarh	Chaura, Kanda, Dharoli and Kaliapatal blocks	-	-	-	-	-	A G2 level general exploration for limestone comprised mapping on 1:4000 scale around Chaura, Kanda, Dharoli and Kaliapatal blocks. Limestone in the area is bluish grey in colour with numerous clay partings. Silica veins were intruded in limestone. Bed rock and channel samples collected from the limestone body for chemical analyses were yielded CaO ranging from 29.64% to 52.78% (avg. 44.75%), MgO 0.87% to 3.83% (avg. 1.92%), Al_2O_3 0.23% to 2.16% (avg. 0.56%), Fe_2O_3 0.1% to 0.73% (avg. 0.22%) and SiO_2 5.56% to 40.09% (avg. 14.80%).
Marble							
Jammu and Kashmir							
Kupwara	In parts of Kupwara – Trehgam areas	1:12500	50.0	-	-	-	G4 stage reconnaissance survey of marble and calc-silicate occurrences for decorative and dimensional stone was taken up in the area. About 16 marble occurrences were delineated in the area. The approximate strike length and width of the marble occurrences varies from about

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							0.08 to about 2.5 km and width of about 20 to about 600 m, respectively. The marble bands are dense (2.55 to 2.7 kg/cm3) having very low water absorption (0.09% to 0.43%), porosity (2.73 to 2.76) and specific gravity (0.23% to 1.13%). The tiles and slabs can be produced for decoration and dimensional use locally. More than 75% of the samples reported CaO concentration more than 48%. The concentration is SiO_2, Al_2O_3, MgO is also appreciable. More than 84% of the marble are good for manufacturing of Portland, Blendable and Beneficiation, White cement and suitable for SMS (OH) and fertilizer industry.
Dunite							
Tamil Nadu							
Thiruchirapalli and Namakkal	Thosur-Mettup-alayam block	1: 12500 1:4000	100.0 5.75	15	590.4	335	A G3 level preliminary exploration for flux grade dunite involved pitting and trenching of 100.0 cu m in the study area. Three major dunite bands i.e. Band 1, 2 & 3 and few disseminated bodies were demarcated. A total of 15 nos. of vertical boreholes with an interval of 300 -500 m spacing were drilled to a depth of 40 m and established the strike length continuity of Band I & II for 6.25 km and 2.6 km, respectively. The BRS samples collected from the well dump showed average MgO values of 26.7%. Core samples analysed from Band I and II, yielded the average MgO values of 29.19 & 19.291% in weathered dunite, 40.27% & 38.12% in fresh dunite and 32.91% & 29.35% in pyroxenite, respectively. The Cr and Ni values of the ultramafic rocks vary between 2817and 4390 ppm and 624 and 2900ppm, respectively.
Graphite							
Jharkhand							
Thiruchirapalli and Namakkal	Latehar, Parsahi, Satbarwa and Ranki Kalan	1: 12500	100.0	-	-	-	A reconnaissance survey for graphite was taken up in Chhotanagpur Gneissic Complex in the survey area. Five bodies of

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							graphite schist were exposed near Dhabadih village for a length of 800 to 1000 m with width ranges from 30-50 m. Graphite schist in and around Hurmur village extend for a of length of about 800 m with 50 m width. Graphite associated with biotite-sillimanite schist were observed near Murma and Tumbagara villages and both bands are 900 m in length and about 50 m in width. Graphite schist observed near Siuri village have 500 m in length with 50 m wide. In south of Ranki Kalan village, graphite schist is 800 m in length and 50 m wide. Proximate analysis of bed rock samples showed fixed carbon ranges from 9% to 32%, volatile matter ranges from 1% to 6%, ash content 65% to 85% and moisture content ranges from 0.1% to 0.6%.
Garhwa	Sewadih-Ranka Kalan areas	1:12500	100	-	-	26	G4 stage reconnaissance survey for graphite mineralization in graphite schist was taken up. The potential zone of mineralization extended from Sewadih village to Sikat village. A total 13 nos.of graphite schist were noticed in this area with a maximum strike length of the largest graphite schist is 674 m and smallest graphite schist is 35 m and its width changes from 1 to 62 m. The result of 26 nos .of bed rock samples were received so far. Fixed carbon analysis of 26 bed rock samples of schist samples showed that fixed carbon content varies from 8.74% to 24.27%, moisture content from 0.01% to 0.20%, volatile content from 0.46 %to 5.44% and ash content from 72.06% to 97.36%. The chemical analysis of 10 nos. of samples for vanadium varies from 192 mg/kg to 1439 mg /kg. The analytical results of remaining samples are awaited.
Saraikela-Kharsawan	Around Largadih-Bachhakocha-Katjor areas	1:12500	100	-	-	-	G4 stage reconnaissance survey for graphite mineralization in carbonaceous phyllite was taken up in the area. Carbonaceous

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							phyllite, a important litho unit for graphite mineral, bodies were delineated in Bachkakocha (1.12 km × 0.37 km), Largadih (1.12 km × 0.2 km), North of Chainpur (1.12 km × 0.18 km), Chandil Gol Chakkar (1.6 km × 0.2 km), Kuchidih (0.75 km × 0.18 km), as thin lenses in Shikli ridge (0.5 km × 0.2 km) and Maranghara Pahar (0.75 km × 0.02 km). Both amorphous and flaky varieties were noticed that soils the finger, has greasy feeling and metallic lustre. Analysis of Fixed Carbon for 3 bed rock samples namely Chandil canal section, Chandil GolChakkar and North of Chainpur yielded 6.20%, 6.20% and 8.55% fixed carbon, respectively. About fifteen samples showed fixed carbon values greater than 2%.
Odisha							
Nayagarh	Tumandi, Narajiparha, Jhiliberena villages, Dasapalla block	1:12500	50.0	-	-	-	A G4 stage reconnaissance survey for graphite mineralization was taken up in the area. There were two places where graphite ore mineralization is demarcated near Tumandi village having band width of about (5 m X 100 m) each and both of them are adjacent to old graphite quarries. Trenching of 50 cu. m. was carried out in and around the identified ore mineralized zones. Its potentiality will be assessed after obtaining chemical results. The Khondalite suite of rocks of Eastern Ghats Mobile Belt hosts graphite mineralization.
Tamil Nadu							
Sivaganga	North of Arasanur village	1:12500	100.0	-	-	197	G4 stage Reconnaissance survey was taken up for graphite and associated mineralization in Sivaganga Graphite belt area. The pitting and trenching of 350 cu m was carried out in the area. Large scale mapping has brought out graphite mineralization associated with sheared quartzo-feldspathic rock in SW of Illuppakkudi, SE of Arasappanpatti and W of Panangadi villages. In Iluppakkudi area, graphite

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							occurrences were noticed to a length of 700 m. A total of 20 trenches were excavated in SW of Iluppaikudi village with collection of 167 trench samples. Analytical results of trench samples indicated that the FC varies from 0.01 to 13.18%, volatile matter varies from 0.58 to 15.07%, moisture varies from 0.02 to 6.20% and ash content varies from 79.91 to 99.02%. However, 30 trench samples showed >5 % FC, 14 trench samples showed >4 and <5 % FC, 10 trench samples showed >3 and <4 % FC, 27 samples showed >2 and <3 % FC value.
Rajasthan							
Alwar	Rajgarh-Saloli area	-	-	-	-	55	G4 stage reconnaissance survey for graphite in parts of Rajgarh-Saloli area involved mapping, pit & trench and sampling. During the field work, different litho-units and their contacts were systematically mapped for graphite and base metal mineralization. The presence of graphite mineralization was observed in the area in carbonaceous phyllite unit exposed in the eastern part of the area. Samples were collected in 100 m x 25 m grid in the mapped area on the basis of surface indications of graphite mineralization. Apart from these, chip/grab samples were also collected from amphibolite bands and marble units for studying any occurrence of mineralization.
POTASH/GLAUCONITE							
Bihar							
Rohta	Pipradih-Bhurwa block	1:4000	4	08	700	36	A G3 level preliminary exploration for glauconitic sandstone was carried out in the study area. All 8 boreholes were drilled vertically upto depth of 80±20 m. The glauconitic sandstone was intersected in three boreholes, while sea green/ khaki green shale in association with pinkish grey limestone was intersected in other 3 boreholes.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							Analytical results of 25 bed rock samples indicated K_2O% >4% in 11 sandstone samples and in other two samples K_2O% reported >5% with maximum of 5.13%.
Potash							
Jharkhand							
Garhwa	Muskaniya-Gareriatola-Barwari area, Bhawanathpur	1:4000	5.0	-	-	150	A G3 level preliminary exploration was carried out for potash fertilizer mineral in the study area. In all completed boreholes, thickest lithounits encountered are dolomitic limestone intercalated with calcareous black shale and calcareous black shale intercalated with dolomitic limestone. The K_2O value of khaki green shale ranges from 3.19 to 8.27% with an average of 5.78%. Khaki green shale intercalated with greyish black shale/ greyish black shale intercalated with khaki green shale gave a value of 2.41 to 9.22% with an average of 5.32%. For dolomitic limestone the value ranges from 0.48 to 3.38 % with an average of 1.97%. Dolomitic limestone intercalated with greyish black shale/ greyish black shale intercalated with dolomitic limestone showed a value of 2.73 to 5.37% with an average of 3.86%. Results of Trench-2 and Trench-3 samples showed K_2O value ranges from 3.43 to 9.36% with an average of 7.74% and 8.32 to 10.21% with an average of 9.63%, respectively. The target lithology i.e. greyish black shale with thin intercalation of khaki green shale samples of borehole yielded K_2O value of 7.92% whereas variants of dolomitic limestone intersected in borehole showed K_2O value of 0.95% to 3.51%. On the basis of chemical results it was concluded that khaki green shale are significant for K_2O while that of dolomitic limestone and dolomitic limestone intercalated with calcareous black shale does not give encouraging values for K_2O.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Punjab							
Fazilka	Sherewala block, South of Abohar	1:4000	7.0	1	815.0	182	A G3 level preliminary exploration for potash in Sherewala block was carried out. A borehole was drilled upto a depth of 815 m. On the basis of core logging and visual estimation, halite cycles were intersected from a depth of 460.75 to 786.20 m. The Geophysical logging of the borehole was carried out up to 509 m. As per geophysical logging, low natural gamma count, low density values were recorded at the depth from 452.4 - 482.9 m and 484.3 - 508.3 m, due to high salinity in the borehole which may indicate halite in the formation.
Rajasthan							
Hanumangarh	Jandawali south block	1:4000	9.1	3	815.0	424	A G3 level preliminary exploration for potash was carried out in Jandawali south block in Satipura sub-basin of Nagaur-Ganganagar evaporite basin. Geophysical logging of three successfully completed boreholes was carried out. In borehole RJNGJS-03, a total of 368.90 m thick Hanseran Evaporite Group (HEG) intersected and expected thickness of mineralized zone is around 306.00 m. In borehole RJNGJS-06, a total of 395.10 m thick HEG intersected and expected thickness of mineralized zone is around 304.00 m. In borehole RJNGJS-10, a total of 388.93 m thick HEG intersected and expected thickness of mineralized zone is around 298.50 m. In borehole RJNGJS-13, halite intersected at 401m depth. Samples of drill cores were collected from halite cycles for chemical analysis of K, Na and other associated elements.
	Jandawali north block	1:4000	5.7	3	1,405	424	A total of 394.50 m cumulative thickness of HEG intersected in between 390.60 to 785.10 m depths. Expected thickness of mineralised zone (visual estimate) is 21.2 m from 660.6 to 681.80 m. Visible

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							mineralization in the form of sylvite and polyhalite was noticed within H2 cycles from 660.6 to 681.80 m. Halite and minor polyhalite is the common association with reddish brown clay, and minor grayish white anhydrite stingers is the common impurities. Commonly polyhalite and clay is found as impurities along the fractures and crystal boundaries. Sylvite is commonly associated with sylvinite (KCl.NaCl). The main potash bearing mineral sylvite/ sylvinite is mainly occurred in H2 halite cycle along with presence of polyhalite. Seven halite cycles were intersected in the drilled boreholes.
Gypsum							
Himachal Pradesh							
Kinnaur	Shalkar block	1:4000	3.0	-	-	-	A G3 level preliminary survey for Gypsum was carried out in the investigation area. Total fifteen channel lines were put across the strike of the Gypsum/Gypsite / limestone bands in Shalkar block. The gypsum (alabaster, selenite variety) at upper stratigraphic level is designated as Zone-A and gypsum at lower stratigraphic level is designated as Zone-B. Gypsum band at upper stratigraphic level (Zone-A) has a strike length of 450 m and average thickness of 65 m. At lower stratigraphic level (Zone-B) gypsum occurs as a pocket with strike length of 115 m and average thickness of 70 m. In gypsum band of Zone-A, three channel lines in gypsum of upper stratigraphic level are having weighted average of gypsum 68.02%, 94.47%, and 73.59%, respectively. Channel line in gypsum pocket of Zone-B had a weighted average of 85.66%.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Lahaul and Spiti	Hurling-Giu area	1:4000	3.0	-	-	-	A G4 stage reconnaissance survey for gypsum was taken up in the study area.Detailed mapping was carried out in two blocks i.e. Giu block (2.2 sq km) and Hurling block (0.8 sq km). In Giu block, Zone-I, the weighted average of gypsum is 91.24%, average thickness 69.47 m. In Zone-II, the weighted average is 87.65%, average thickness 23.03 m. In Zone-III, the weighted average of gypsum is 88.88%, average thickness 43.93 m. In Hurling block, two pockets (A and B) of alabaster variety of gypsum intercalated with limestone were delineated with cumulative strike length of mineralized zone of about 485 m. In Hurling block, the weighted average of gypsum is 89.87% with average thickness of 73.36 m.
Phosphatic Nodules							
Tamil Nadu							
Ariyalur	Karai formation, Uttattur group sediments	1:12500	100	-	-	-	During large scale mapping in Karai formation, Uttattur group of cretaceous sediments, Cauvery basin in parts of toposheet 58I/16, 200.0 cu m of trenching was taken up. Two mineralized zones were delineated for resource estimation of phosphatic nodule; one is northern zone occurring in the western parts of Aiyanpuram village with an area of 9.6 km2, length of 8.25 km and 2.68 km wide zone and the other southern zone, situated at Nambakurichchi area covering 2.82 sq km area, 2.71 km strike length and 2.4 km wide. Nodules were seen as embedded nodules at certain depth in the host rock and its occurrence was very scanty. The thickness of phosphatic nodule rich host rock was having approximate thickness of 326 m. The chemical analysis of bed rock showed P_2O_5 ranging from 0.01 to 4.049% and P_2O_5 values of PTS were reported to be 2.15 to 27.24%.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Phosphorite							
Gujarat							
Kachchh	Deshalpar, Vandhay, Samatra, Bharasar areas	1:12500	100.0	-	-	-	Phosphate rock reported mostly in the cherty limestone, pisolitic limestone & calcareous fossiliferous coarse grained sandstone. These lithounits showed positive indication for phosphorous with Shapiro kit. The limestone has two bands with cumulative thickness 5-3 m. Pisolitic limestone occurs as thin bands & patches of 10-15 cm thickness, highly fossiliferous. The bands are very thin & mostly reported as dislocated blocks on the surface. Calcareous fossiliferous coarse grained sandstone thickness was 20-30 cm showed relatively less indication for phosphorous.
Commissioner of Geology and Mining, Gujarat							
Limestone							
Gir Somnath	Barevala Singhar, Madhavpur Ablash, Pipalva, Gangetha, Bhuva Timbi, Kodidra, Sindhaj, Kukras	-	-	90	3723	1339	The exploration was taken up with an objective to establish auctionable mineral resources. Exploration is under progress.
Dvbhumi Dwarka	Pachtar	-	-	5	109	424	The exploration was taken up with an objective to establish auctionable mineral resources. About 7.49 million tonnes of resources were estimated during the year.
Amreli	Jafrabad	-	-	27	1350	621	The exploration was taken up with an objective to establish auctionable mineral resources. Exploration is under progress.
Bentonite							
Kachchh	Khirsara/Miyani, Rajdhanjar I & II & Nundhatad	-		604	23779.7	3139	The exploration was taken up with an objective to establish auctionable mineral resources. Exploration is under progress.
Chinaclay							
Kachchh	Nadapa, Kali Talavadi & Mokhana	-	-	383	24139	4090	The exploration was taken up with an objective to establish auctionable mineral resources. Exploration is under progress.

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Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
MECL							
Limestone							
Chhattisgarh							
Bilaspur	Raniraon-Gondaiya block & village, Kota Tehsil	1:5000	5.00	26	1166.50	1591	The resources estimated were at 33.80 million tonnes of cement grade limestone and 52.59 million tonnes of blendable grade limestone under inferred category. Subgrade material estimated at 25.47 million tonnes with 36.21% CaO, 3.78% MgO, 15.28% SiO_2, 4.08% Al_2O_3, 2.89% Fe_2O_3 & 33.81% LOI under UNFC code 332.
Madhya Pradesh							
Satna	Jamodi-Mahanna Part-B, Raghuraj Nagar tehsil	1:4000	9.00	36	1322.50	1392	The resources estimated of cement grade was at about 90.29 million tonnes with 44.18% CaO, 2.05% MgO, 9.11% SiO_2 under UNFC code 332. Also estimated about 72.65 million tonnes of of limestone resources having 37.62% CaO, 5.10% MgO, 14.81% SiO_2 under UNFC code 332.
	Naubasta-Kolard block, Nagod tehsil	1:4000	15.90	36	1674.00	1392	The total resources in Zone-I and Zone-II was estimated at about 166.05 million tonnes with average grade of 44.77% CaO, 2.10% MgO, 10% SiO_2 under UNFC code 332. Also estimated about 81.59 million tonnes of sub-grade limestone resources having 35.83% CaO, 3.99% MgO, 18.97% SiO_2 under UNFC code 332.
Neemuch	Khedarathore ML area of CCI, Jawad tehsil	1:4000	1.64	10	1021.50	1112	The reserves/resources in the ML area was estimated at about (i) 91.51 million tonnes of cement grade limestone with 44.29% CaO, 1.53% MgO, 14.13% SiO_2, (ii) 44.42 million tonnes of blendable grade limestone with 40.79% CaO, 1.65% MgO, 15.32% SiO_2, and (iii) 155.57 million tonnes of sub-grade limestone with 38.20% CaO, 1.74% MgO, 21.54% SiO_2 under UNFC code 332.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
	Nayagaon ML area of CCI, Jawad tehsil	1:4000	3.368	21	1968.00	1714	The resources in the Nayagaon ML area was estimated at about (i) 136.94 million tonnes of cement grade limestone with 43.39% CaO, 1.06% MgO, 12.61% SiO_2, (ii) 68.02 million tonnes of blendable-grade limestone with 41.18% CaO, 1.40% MgO, 17.05% SiO_2, and (iii) 156.59 million tonnes of sub-grade limestone with 37.41% CaO, 1.56% MgO, 22.17% SiO_2 under UNFC code 332.
Karnataka							
Gulbarga/ Kalaburgi	Diggaon village & block, Chittapur Tehsil	1:4000	7.85	13	1245.40	1471	The reserves/resources in the Diggaon area was estimated at about (i) 530.8 million tonnes of cement grade limestone with 45.45% CaO, 1.00% MgO, 11.59% SiO_2 & (ii) 281.87 million tonnes of blendable-grade limestone with 41.31% CaO, 0.98% MgO, 16.31% SiO_2 under UNFC code 333.
Gulbarga/ Kalaburgi	Udagi village & block, Chittapur Tehsil	1:4000	6.45	12	1058.6	1.175	The resources in the Udagi area was estimated at about (i) 385.35 million tonnes of cement grade limestone with 45.66% CaO, 0.55% MgO, 12.98% SiO_2 & (ii) 74.06 million tonnes of blendable-grade limestone with 42.86% CaO, 0.55% MgO, 17.45% SiO_2 under UNFC code 333.
Potash							
Rajasthan							
Bikaner	Lakhasar block	1:10000	13.107	7	4695.50	2.995	The resources has been estimated at 42.22 million tonnes at 3% K cut-off of 4.48% K under UNFC code (334) and 44.972 million tonnes at 3% K cut-off of 5.20% K under UNFC code 333.
Magnesite							
Rajasthan							
Udaipur	Iswal-Selu-Tula area	1:12500	104.00	20	669.00	1.044	G4 level exploration was taken up for base metals and magnesite in this area. The resources of magnesite has been estimated at about 10.05 million tonnes with average grade of 39.76% MgO, 3.46% CaO, 2.40% , SiO_2, 5.65%

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							Fe_2O_3, 0.23% Al_2O_3 under UNFC code 334.
Magnesite/Dunite, Nickel, Chromium							
Tamil Nadu							
Namakkal & Tiruchirapalli	Namakkal block	1:12,500	251.00	3	558.00	1362	G4 level exploration was taken up for magnesite/dunite, nickel, chromium in Namakkal block. The resources of dunite has been estimated at about 53.15 million tonnes with average grade of 35.20% MgO, 2.82% CaO, 32.07% SiO_2, 13.27% Fe_2O_3, 0.61% Al_2O_3 under UNFC code 334 and about 7.20 million tonnes dunite with average grade of 35.42% MgO, 2.82% CaO, 32.05% SiO_2, 13.20% Fe_2O_3, 0.61% Al_2O_3 under UNFC code 333.
Department of Mines & Geology							
Andhra Pradesh							
Limestone							
YSR Kadapa	Bhima-gundam block, Peddamudium	-	6.979	34	749.00	505	A total of 154.89 million tonnes of limestone resources have been estimated with 46.8% CaO under UNFC code 332
	Gundlakunta block, Peddamudium	-	12.58	68	2825.00	2713	A total of 807.10 million tonnes of limestone resources have been estimated with 45.98% CaO under UNFC code 332
	Dommara-nandhyala block, Mylavaram	-	20.1	101	5409.00	5070	A total of 1676.40 million tonnes of limestone resources have been estimated with 46.19% CaO under UNFC code 332
	Devagudi - block, Jamm-alamadugu	17.19	100	4085.50	3491		A total of 1225.16 million tonnes of limestone resources have been estimated with 45.30% CaO under UNFC code 332
Guntur	Madinapadu block, Dachepalli	-	6.60	38	2328.00	2355	The Chemical analysis reports of samples are awaited.
	Mutyalampad-utangeda block, Dachepalli	-	4.80	28	2034.00	2015	The Chemical analysis reports of samples are awaited.
	Tageda block, Dachepalli	-	7.16	39	2850.00	2993	The Chemical analysis reports of samples are awaited.
	Ramapuram block, Dachepalli	-	4.07	23	1693.00	1758	The Chemical analysis reports of samples are awaited.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Directorate of Mines & Geology, Rajasthan							
Limestone							
Dholpur	Moti Kotra, jhajjewari, Karuapura Bari Tehsil & Gulawali, Sumerpur Tehsil	1:10000 1:4000	40.00 5.00	-	-	10	During previous studies, limestone exposures of dimension 70 m x 4-6m, 50 m x 5-7 m, 70 m x 10-12 m, 200 m x 8-12 m, 320 m x 12-15 m, 80 m x 10-15 m and 300 m x 12-20 m and 220 m x 7-10 m has been mapped in the area. Project is continued.
Jaisalmer	N/v Sam Tehsil	1:10000 1:4000	10.00 2.00	14	523.0	438	The thickness of SMS grade limestone varied from 5.25 m to 22.50 m and underlying chalky cement grade limestone varied from 7.50 m to 36.00 m. Resources in the area were estimated at 56.40 million tonnes of SMS grade limestone and 122.50 million tonnes of cement grade limestone. The project is continued.
Jodhpur	Borunda, Haryadhana, Digarna, Sinla, Bitan, Kurdaya, Bilara Tehsil	1:10000 1:4000	20.00 5.00	-	-	20	The project is continued.
Pali	Ramasnibala, Mandla, Asan & Dhaneri, Sojat Tehsil	1:10000 1:4000	20.00 5.00	-	-	20	-
Bhilwara	N/v Ladpura, Thela, Chitauriya, Dharkarkhedi,etc Mandalgarh Tehsil	1:2000	2.75	4	173.0	278	-
Kota	N/v Nimana-Dunia, etc, Ramganj Mandi Tehsil	1:4000	3.00	11	362.0	104	Limestone resources of marginal to cement grade estimated at about 91.34 million tonnes and Splittable limestone at about 92.33 million tonnes.
Baran	N/v Augar, Tanda, Majola, etc Shahbad Tehsil	1:10000 1:4000	10.00 3.00	-	-	12	-
Chittorgarh	N/v Binota, Tatarmala, Khorip, etc	-	-	-	-	-	-
	N/v Samriya kalan, Nathuramji ka khera, etc.	1:4000	3.00	-	-	-	-

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
	N/v Sindwari-Ramakhera-Satkhanda, etc	-	-	10	526.0	377	-
Sandstone							
Bharatpur & Dausa	N/v Kalwan, Sikri Tehsil, N/v Dumariya, Roopwas Tehsil & N/v Nangal, Pahari Tehsil	1:4000	2.00	-	-	04	-
Bundi	N/v Dhaneshwar Tarela Tehsil	1:4000	1.20	-	-	-	-
Sandstone / siliceous limestone							
Jaisalmer	N/v Rupsi	1:10000 1:4000	10.00 3.00	-	-	-	-
Granite							
Jalore	N/v Kot-Kasta & Tavab, Bhinmal Tehsil	1:10000 1:4000	10.00 3.00	-	-	09	-
Sirohi	N/v Veerwara, Naya-Sanwara, Kukrikheda, etc in Pindwara & Sheoganj Tehsils	1:10000 1:4000	25.00 2.30	-	-	07	-
Masonry Stone							
Sirohi	N/v Pamera Reodar Tehsil	1:10000 1:4000	10.00 1.00	-	-	03	-
Blockable pegmatite,Granite, Masonry stone							
Rajsamand	N/v Gurha-Chhipala, Kawas ka Gurha, etc Bhim Tehsil	1:10000 1:4000	3.25 3.25	-	-	06	-
Siliceous earth							
Barmer	N/v Dharvi, Fatehpura & Utal Tehsil Sheo	1:4000	1.00	-	-	-	Siliceous earth is seen.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
	Utal Tehsil Sheo						in the nala cutting and also below the soil cover. Total four bands of siliceous earth has been identified in the area. First band of about 1.0 to 1.5 m thickness extend to a length of around 500 m with soil cover of 0.4 m to 0.6 m; second band of about 1.5 to 2.0 m thickness extend to a length of around 50 m with soil cover of 0.3 m to 0.5 m; third band of about 1.5 to 2.0 m thickness extend to a length of around 45 m with soil cover of 0.6 m to 0.8 m & fourth band of about 1.5 to 2.0 m thickness extend to a length of around 100 m with soil cover of 0.9 m to 1.0 m.
Jaisalmer	N/v Mandai, Fatehgarh Tehsil	1:10000	3.00	-	-	-	-
Directorate of Geology, Odisha							
Limestone							
Odisha							
Bolangir	Telipadar	-	-	11	404.00	113	The project is contunuing.
Quartz & Quartzite							
Mayurbhanj	Purunapani-Tilodaia-Tilakchuin	1:5000	0.96	-	-	23	One small patch of quartzite float zone was encountered in northern part of the area. The area is devoid of economically viable exposures of quartzite.
Jharsuguda	Bhikampali & Kanaktora	1:5000	0.51	-	-	48	A small quartz body having strike length of 540 m and width of 310 m was located around NE of Bhikampali near Baunsepali village. Trial excavation of 12 cu. m was carried out in 6 pits.
Sundargarh	Soroda	1:5000	0.60	-	-	108	The quartz mineralisation is exposed around N of Soroda over a strike length of 900 m with width of 350 m. located around NE of
Quartz							
Kalahandi	Dabjharan, Junagarh subdivision	1:5000	0.105	-	-	21	A float quartz zone was noticed 1 km south of Bagjharan having aerial extension of 100m x 86 m.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							About 17.00 cu. m material was excavated in 5 pits.
Bolangir	Burbuda, Biramitrapur subdivision	1:5000	0.50	-	-	38	A pegmatite having strike length of 150 m with width of 70 to 100 m was noticed south of Hatilmunda village. Another pegmatite exposure was noticed WNW of Hatilmunda village for strike length of 180 m with width varying from 50 m to 70 m. About 35.60 cu. m material was excavated in 9 pits. Chemical analysis of quartz samples indicate that SiO_2 content varies from 92.54% to 99.21% and Fe_2O_3 content varies from 0.1% to 0.23%.
	Kadalimunda, Saintala tehsil	1:5000	0.25	-	-	19	The pegmatite is exposed for a strike length of 120 m with width varying from 50 n to 70 m. In quartz samples, SiO_2 content varies from 88.20% to 89.08% and Fe_2O_3 content varies from 0.1% to 0.18%.
Graphite							
Dhenkanal	Bandhabhuin	1:2000	0.445	-	-	7	An area of 0.25 sq. km was explored by SP survey to delineate anomalous zone for grapite mineralisation. The surveyed area is found to be potential for graphite occurrences.
	Karabira	1:5000	0.36	8	468.00	-	The minimum depth of intersection of graphite horizon in boreholes varied from 6.5 m to 30.20 m while the maximum depth of mineralisation varied from 65.00 m to 78.60 m. Drilling is under progress. The cumulative mineralisation encountered in BH was 91.30m.Graphite was flaky in nature.
Rayagada	Khalpadar	1:5000	0.54	12	259.30	133	Depth of boreholes varied from 16.50 m to 29.85 m and apparent thickness of graphite varied from 1.60 m to 25.60 m. The fixed carbon varied from 0.78% to 7.15%.

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Decorative Stone and other minor minerals							
Gajapati	Endrima village Mohana tehsil	1:25000 1:4000	100.00 0.35	-	-	16	Three decorative/dimension stone blocks have been identified, i.e., NE of Kampagud (350 m x 160 m), N of Kampagud (400 m x 300 m) and E of Deulakhani (370 m x 350 m). Total 4 cu. m trial excavation was carried out in 4 pits.
Kandhamal	Pabura village	1:25000	130.00	-	-	12	Decorative/dimension Stone could not be located.
Pyrophyllite							
Keonjhar	Jamudiha	1:5000	0.45	3	39.05	67	Thickness of pyrophyllite body is about 4 m to 5 m. Boreholes were drilled upto a maxumum depth of 17.05 m. Chemical analysis of channel samples indicates Al_2O_3 content varies from 20.12% to 28.46% and SiO_2 content varies from 62.66% to 70.72%. Drilling could not be completed due to want of forest clearance.
Pyroxenite/Serpentinite							
Keonjhar	Kaliahata	1:10000 1:2000	30.00 3.6	3	39.05	120	Two occurrences of ultramafics i.e. (i) peridotite/ serpentinite around Baiganpal area (800 m x 600 m) and (ii) pyroxinite in Bandhuni hill of Benamunda area (1700 m x 800 m) were delineated.
China clay							
Mayurbhanj	Dumuria Karanji tehsil	1:2000	0.5	30	621.00	441	Chinaclay / kaolin occurs as lenses/pockets of various size and shape below a thin soil cover and laterite of average thickness 2.5 m. Cumulative thickness of clay is about 446.21 m. Kaolin occurs as lenses/pockets of different sizes and shapes below a thin soil cover and laterite of

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Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
							average thickness 2.5 m.
Dhenkanal	Bhairpur	1:10,000 1:5000	100.00 0.35	-	-	12	Three small clay patches of thickness upto 3.1 m was located. Preliminary analysis of samples showed that Al_2O_3 content varies from 26.44% to 34.64%, Fe from 0.78% to 3.36% and SiO_2 from 41.80 to 47.32%.
DGM, Chhattisgarh							
Limestone							
Bhatapara-Balodabazar	Sarseni-Guma area	1:50000 1:4000	120.00 1.08	17	1028.65	1106	The total resources of limestone in the study area has been estimated at about 111.87 million tonnes which includes 14.87 million tonnes of indicated category and 97.00 million tonnes of inferred category.
Dolomite/Limestone							
Bastar	Mohpalbarai area	1:50,000 1:4000	160.00 1.89	28	830.00	690	Dolomite and limestone are stomatolitic in nature in the study area and shale partings are present at regular intervals. A total of 27.00 million tonnes of dolomite resources and 33.70 million tonnes of limestone resources has been estimated in the area.
DGM, Maharashtra							
Limestone							
Chandrapur	Chandrapur	1:25,000	393.44	-	-	-	-
Yavatmal	Murti block, Wani Tahsil	1:25,000 1:5,000	7.00 4.25	7	391.00	254	A total of 2.99 million tonnes of cement grade and 0.69 million tonnes of blendable grade limesone were estimated. Exploration is continued.
	Kundra-Krushnapur block, Wani Tahsil	1:25,000 1:5,000	10.00 5.8	3	157.00	135	The area is not promising for further exploration.
	Kolgaon - Wegaon block, Zari-Jamni Tahsil	1:25,000	7.00	3	111.00	90	On the basis of chemical analysis it is observed that CaO, MgO and SiO_2 content for limestone ranges from 31.50 - 50.27%, 0.91 - 20.00% and 2.78% - 27.55%, respectively. A total of 0.45 million tonnes of cement grade limestone and 0.77 million tonnes of cement grade/ blendable grade limestone resources have been estimated during the year.

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Table - 8 (Concld)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Chandrapur	Lkhmapur-Dhunki- Karwa village Korpana Tahsil	1:5000	1.46	18	1120.50	482	G2 level exploration work has been proposed to further investigate the extent of limestone beds in the area.
	Borgaon-Khairgaon Karwa village Korpana Tahsil	1:12500	38.65	-	-	52	The exploration work was taken up to identify and prove occurrences of limestone deposit in the area. Further, a G3 level exploration work will be taken up after obtaining permission from forest department.
Building stone/construction material							
Jalna	Ambad Tehsil	1:50000	110.00	-	-	-	-
Directorate of Mines & Geology / Telangana State Mineral Development Corporation Ltd. Telangana							
Limestone							
Suryapet	Mellacheruvu village & Mandal (Mellacheruvu cluster-1)	1:12500	57.77	6	314.00	417	G4 stage exploration led to estimation of about 367.72 million tonnes of cement grade limestone resources with an average CaO 48.01%. During reconnaissance survey, potential area of 41.45 sq.km of cement grade limestone has been identified within cluster for further G3/G2 stage exploration
	Mattampally village & Mandal (Mattampally cluster-2)	1:12500	14.65	4	200.00	226	G4 stage exploration led to estimation of about 59.50 million tonnes of cement grade limestone resources with an average CaO 46.97%. During reconnaissance survey, potential area of 8.38 sq.km of cement grade limestone has been identified within cluster for further G3/G2 stage exploration
	Raghunath-apalem village, Mattampally Mandal (Mattampally cluster-3)	1:12500	46.58	4	200.00	327	G4 stage exploration led to estimation of about 158.21 million tonnes of cement grade limestone resources with an average CaO 47.55%. During reconnaissance survey, potential area of 31.73 sq.km of cement grade limestone has been identified within cluster for further G3/G2 stage exploration

Table - 8 (Concld)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
	Ramapuram village, Mellacheruvu Mandal (Ramapuram Cluster-5)	1:12500	55.87	2	100.00	111	G4 stage exploration led to estimation of about 67.57 million tonnes of cement grade limestone resources with an average CaO 45.62%. Further, a G3/G2 level exploration work will be taken up in the delineated cement grade limestone block. In Telangana state, potential area is around 14.33 sq.km. Out of the total area 55.87 sq.km, 19.58 sq.km is in Telangan state and rest lies in Andhra Pradesh.
	Dondapadu village, Mellacheruvu Mandal (Dondapadu Cluster-6)	1:12500	46.82	4	197.00	241	G4 stage exploration led to estimation of about 45.20 million tonnes of cement grade limestone resources with an average CaO 44.89%. Further, a G3/G2 level exploration work will be taken up in the delineated cement grade limestone block.
Nalgonda	Wazigudem Irkigudem village, Dhameracherla Mandal (Cluster-4)	1:12500	18.12	4	143.00	169	G4 stage exploration led to estimation of about 45.58 million tonnes of cement grade limestone resources with an average CaO 46.87%. During reconnaissance survey, potential area of 12.19 sq.km of cement grade limestone has been identified within cluster for further G3/G2 stage exploration
Vikarabad	Jwangi village, Basheerabagh Mandal (Cluster-7)	1:12500	16.11	4	58.50	54	No potential area was located for further exploration.
	Malkapur village, Tandur Mandal (Cluster-8)	1:12500	20.87	2	85.50	115	G4 stage exploration led to estimation of about 94.11 million tonnes of cement grade limestone resources with an average CaO 48.74%. During reconnaissance survey, potential area of 17.69 sq.km of cement grade limestone has been delineated for further G3/G2 stage exploration.

Table - 8 (Concld)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Tamil Nadu Minerals Ltd.							
Tamil Nadu							
Graphite							
Sivaganga	Senthiudauna-. thapuram, Kumarpatti & Pudupatti village,s, Sivaganga taluka	-	-	-	-	-	-
Limestone							
Ariyalur	Periyanagalur village, Ariyalur taluka	-	-	-	-	-	-
Vermiculite							
Tirupattur	Sevathur & Elavampatti villages, Tirupattur taluka	-	-	-	-	-	-
Directorate of Mineral Resources, Meghalaya							
Meghalaya							
Limestone							
East Khasi Hills	Nongtri Near	-	-	1	17.05	20	The thickness of limestone bed ranged from 70-120 m. Analytical results were awaited. Limestone exposed in the area ranged from 10-15 m in thickness and grey in colours fine to medium gniged, hard compact.
	Lawbah						
East Jaintia Hills	Ummat	!:50000	10.3	-	-	20	
	Lakadong	1:4000	1.25				
Quartz							
South-West Khasi Hills							
	Nongtynger-Langsohkhlam near Phlangdiloin	!:50000 1:4000	9.5 3.6	2	-	52	
Sillimanite							
West Khasi Hills	Thaiem, Mawkhar & Mawkdep area, Riangdo	!:50000 1:4000	9.0 1.5	-	-	29	

Table - 8 (Contd)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq.km)	Boreholes	Meterage		
Directortae of Geology and Mining, Uttar Pradesh							
Dimensional Granite							
Lalitpur	Madawara, & Talbehat	1:50000	50.00	-	-	06	Different varieties of dimensional granite in six new blocks aggregating an area of 20.08 hect. were identied. Samples of different sizes were collected for evaluation of quality, cutting /polishing etc.
Baryte							
Lalitpur	Mathara Dang (Bar-Larwari) area	1:12500	60.00	-	-	74	During G4 stage reconnaissance survey, trenching & pitting (2 each) of 28 cu m was carried out alongwith collection of samples. The chemical analysis showed the presence of baryte and base metals.
Rock phosphate							
Lalitpur	Semarkhera, Tori, Pisnari & Sonrai	1:1000	0.5	1	96.05	281	A G2 stage study was carried out to assess resources of rock phosphate in the area. The total strike length of the phosphatic sediments is about 7.5 km from Samarkhera in the east upto Sonrai in the west.Three trenches were excavated and collected 186 samples. The study is under progress.