Indian Minerals Yearbook 2019

(Part- I)

58th Edition

STATE REVIEWS (Madhya Pradesh)

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GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

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MADHYA PRADESH

Mineral Resources

Madhya Pradesh is the only diamond producing State in the country and is the leading producer of copper conc., diaspore, pyrophyllite, manganese ore, limestone and clay (others). The State hosts the country's 90% diamond, 74% diaspore, 55% laterite, 48% pyrophyllite, 41% molybdenum, 27% dolomite, 19% copper ore, 18% fireclay, 12% manganese and 8% rock phosphate ore resources.

Important mineral occurrences in the State are: **bauxite** in Balaghat, Guna, Jabalpur, Katni, Mandla, Rewa, Satna, Shahdol, Shivpuri, Sidhi & Vidisha districts; **calcite** in Barwani, Jhabua, Khandwa & Khargone districts; **china clay** in Betul, Chhatarpur, Chhindwara, Gwalior, Hoshangabad, Jabalpur, Khargone, Narsinghpur, Raisen, Satna, Shahdol & Sidhi districts; **copper** in Balaghat, Betul & Jabalpur districts; **coal** in Betul, Shahdol & Sidhi districts; **diamond** in Panna district; **diaspore & pyrophyllite** in Chhatarpur, Shivpuri & Tikamgarh districts; **dolomite** in Balaghat, Chhindwara, Damoh, Dewas, Harda, Hoshangabad, Jabalpur, Jhabua, Katni, Mandla, Narsinghpur, Sagar & Seoni districts; **fireclay** in Betul, Chhindwara, Jabalpur, Katni, Narsinghpur, Panna, Sagar, Shahdol & Sidhi districts; **iron ore (haematite)** in Betul, Gwalior, Jabalpur & Katni districts; **limestone** in Balaghat, Chhindwara, Damoh, Dhar, Hoshangabad, Jabalpur, Jhabua, Khargone, Katni, Mandsaur, Morena, Narsinghpur, Neemach, Rewa, Sagar, Satna, Sehore, Shahdol & Sidhi districts; **manganese ore** in Balaghat and Jhabua districts; **ochre** in Dhar, Gwalior, Jabalpur, Katni, Mandla, Rewa, Satna, Shahdol & Umaria districts; **pyrophyllite** in Chhatarpur, Sagar, Shivpuri & Tikamgarh districts; **quartz/silica sand** in Balaghat, Dewas, Dhar, Jabalpur, Khandwa, Khargone, Morena, Rewa & Shahdol districts; **talc/steatite/soapstone** in Dhar, Jabalpur, Jhabua, Katni, Narsinghpur & Sagar districts and **vermiculite** in Jhabua district.

Other minerals that occur in the State are: **barytes** in Dewas, Dhar, Shivpuri, Sidhi & Tikamgarh districts; **calcareous shales** (used in slate pencil) in Mandsaur district; **felspar** in Jabalpur & Shahdol districts; **fuller's earth** in Mandla district; **gold** in Jabalpur & Sidhi districts; **granite** in Betul, Chhatarpur, Chhindwara, Datia, Jhabua, Panna, Seoni & Shivpuri districts; **graphite** in Betul & Sidhi districts; **gypsum** in Shahdol district; **lead-zinc** in Betul district; **molybdenum** in Balaghat district; **potash** in Panna district; **quartzite** in Sehore district; **rock phosphate** in Chhatarpur, Jhabua & Sagar districts; and **sillimanite** in Sidhi district (Table - 1). The reserves/resources of coal along with various coalfields in Madhya Pradesh are furnished in Table - 2.

Exploration & Development

The details of exploration activities conducted by GSI and other various agencies during 2018-19 are furnished in Table - 3.

Production

Madhya Pradesh was the sole producer of diamond. Apart from this, coal, bauxite, copper ore & concentate, iron ore, manganese ore, limestone and phosphorite are the principle mineral produced in the State.

The value of minor mineral's production is estimated as ` 5,646 crore for the year 2018-19.

There were 213 reporting mines in 2018-19 in case of MCDR minerals (Table-4).

Mineral-based Industry

The present status of each Mineral-based Industry is not readily available. However, the important large and medium-scale mineral-based industries in the Organised Sector in the State are furnished in Table-5.

Table – 1 : Reserves/Resources of Minerals as on 1.4.2015: Madhya Pradesh

Mineral	Unit	Reserves				Remaining Resources								Total resources (A+B)
		Proved STD 111	Probable		Total (A)	Feasibility STD211	Pre-feasibility		Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	
			STD121	STD122			STD221	STD222						
Barytes	tonne	-	-	-	-	-	18500	4472	-	35000	233940	-	291912	291912
Bauxite	'000 tonnes	11979	3313	8299	23591	12566	15084	6013	11061	54484	50590	-	149797	173388
Calcite#	tonne	-	-	5175	5175	215327	35077	160421	20250	180226	358636	97476	1067412	1072587
China clay#	'000 tonnes	357	474	902	1733	2882	406	3774	621	415	12017	-	20115	21848
Copper														
Ore	'000 tonnes	141950	-	12580	154530	17400	-	-	31560	550	79389	-	128899	283429
Metal	'000 tonnes	1887.93	-	148.44	2036.37	189.66	-	-	320.84	4.13	867.5	-	1382.13	3418.5
Diamond	carat	959500	-	159	959659	-	-	-	104118	-	27645359	-	27749477	28709136
Diaspore#	tonne	2380710	341047	2814601	5536358	96241	488094	460808	13696	109792	810667	46068	2025365	7561723
Dolomite#	'000 tonnes	23765	10078	18714	52557	33685	94599	102857	33030	295222	1584534	114799	2258839	2311395
Felspar#	tonne	-	-	-	-	10330	-	6610	-	-	339851	-	356791	356791
Fireclay#	'000 tonnes	390	4192	3020	7603	2139	7164	4975	1551	2129	100977	100	119036	126639
Fullers Earth##	tonne	-	-	-	-	-	-	-	-	-	117200	-	117200	117200
Gold														
Ore (Primary)	tonne	-	-	-	-	-	-	-	-	5841000	1947000	-	7788000	7788000
Metal (Primary)	tonne	-	-	-	-	-	-	-	-	6.18	2.22	-	8.4	8.4
Granite## (Dim. Stone)	'000 cu. m	-	160	-	160	-	-	-	-	-	1885924	108000	1993924	1994084
Graphite	tonne	-	-	-	-	-	-	-	-	-	3456660	2280000	5736660	5736660
Gypsum#	'000 tonnes	-	-	-	-	-	-	-	-	-	69	-	69	69
Iron Ore (Haematite)	'000 tonnes	44203	3635	14225	62063	48412	3650	36774	23243	9008	146803	10	267900	329963
Laterite#	'000 tonnes	12534	3355	7917	23807	8715	1631	16077	3189	1519	167527	169678	368336	392143
Lead-Zinc													-	-
Ore	'000 tonnes	-	-	-	-	129	117	-	1510	4006	5930	3150	14841	14841
Lead Metal	'000 tonnes	-	-	-	-	-	-	-	26.12	5.13	5.04	-	36.29	36.29
Zinc Metal	'000 tonnes	-	-	-	-	5.2	4.71	-	114.76	41.93	186.02	101.12	453.74	453.74
Limestone	'000 tonnes	816293	1093490	545321	2455103	419938	256187	498590	566011	830331	4045838	269859	6886754	9341858
Manganese Ore	'000 tonnes	20227	6760	2904	29891	5802	2779	6421	325	10481	2015	-	27823	57713
Marble##	'000 tonnes	-	-	4551	4551	-	-	-	-	-	-	-	-	4551

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Table – 1 (concld)

Mineral	Unit	Reserves				Remaining Resources								Total resources (A+B)
		Proved STD 111	Probable		Total (A)	Feasibility STD211	Pre-feasibility		Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	
			STD121	STD122			STD221	STD222						
Molybdenum														
Ore	tonne	-	-	-	-	-	-	-	-	-	8000000	-	8000000	8000000
Contained MoS_2	tonne	-	-	-	-	-	-	-	-	-	5020	-	5020	5020
Ochre#	tonne	1605342	194757	1895247	3695346	681904	1653225	5402710	356344	2577575	3732142	749250	15153150	18848495
Potash	Million tonnes	-	-	-	-	-	-	-	-	1206	-	-	1206	1206
Pyrophyllite#	tonne	9786485	2242501	1907116	13936102	1860354	2976581	2738198	520801	3294772	2984100	248405	14623211	28559313
Quartzite#	'000 tonnes	-	-	-	-	-	-	-	-	-	832	-	832	832
Quartz-Silica Sand#	'000 tonnes	129	30	1781	1940	516	-	920	791	316	2717	-	5261	7201
Rock Phosphate	tonne	5999399	5179	1492370	7496948	6460616	14981336	15702042	-	2730000	10629258	50625	50553877	58050825
Shale#	'000 tonnes	55	9	2	66	295	-	1459	-	-	33	-	1787	1853
Sillimanite	tonne	-	-	-	-	-	-	-	-	-	0	101600	101600	101600
Silver														
Ore	tonne	-	-	-	-	-	-	-	-	2096000	1120000	-	3216000	3216000
Metal	tonne	-	-	-	-	-	-	-	-	150.61	9.25	-	159.86	159.86
Talc-Steatite-Soapstone#	'000 tonnes	185	20	79	283	179	378	1609	-	1679	6107	-	9952	10235
Vermiculite	tonne	-	-	-	-	197	-	66	-	-	66	-	329	329

Figures rounded off

Note: *The proved and indicated balance recoverable reserves of Natural Gas in the State as on 01.04.2019 were 31.55 billion cu. m*

 # Declared as minor mineral vide Gazette Notification dated 10.02.2015

Minor Mineral before Gazette Notification dated 10.02.2015

Table – 2 : Reserves/Resources of Coal as on 1.4.2019 : Madhya Pradesh

(In million tonnes)

Coalfield	Proved	Indicated	Inferred	Total
Total	**12182.45**	**12735.98**	**3874.67**	**28793.10**
Johilla	185.08	104.09	32.83	322.00
Umaria	177.70	3.59	–	181.29
Pench-Kanhan	1515.71	991.93	982.21	3489.85
Pathakhera	290.80	88.13	68.00	446.93
Gurgunda	–	84.92	53.39	138.31
Mohpani	7.83	–	–	7.83
Sohagpur	2129.18	5659.25	293.47	8081.90
Singrauli	7876.15	5804.07	2444.77	16124.99

Source: *Coal Directory of India, 2018-19*

Table –3 : Details of Exploration Activities in Madhya Pradesh, 2018-19

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
GSI							
Coal							
Singrauli	Sarai-Uphradol block, Singrauli coalfield	-	-	6	3533.60	-	G2 stage regional exploration for coal in Sarai-Uphradol block, Singrauli coalfield, Singrauli district was carried out involving a total of 3533.60 m drilling in six boreholes. The intersected thickness of Raniganj Formation in borehole is 85.80 m. The intersected thickness of Barren Measures was found to range from 171.80 m to 282.21 m whereas in Barakar Formation it showed variations from 377.27 m to 437.80 m. Intersected thickness of Talchir Formation is 20.63 m. Seven regional Barakar coal seams were intersected in most of the boreholes between the depths of 245.50 m and 540.76 m. The cumulative coal seam thickness showed variations from 7.75 m to 18.39 m whereas thickness of individual coal seam range from 0.59 m to 4.52 m. The continuity of coal seams was established to nearly 6.70 km along the strike and about 3.40 km along the dip direction within the block.

(contd)

Table – 3 (contd)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
Chhindwara	Kahua-Khireti sector, Pench Valley Coalfield	1:10000	22	5	2520.25	-	G3 stage regional exploration for coal was carried out in Kahua-Khireti sector, Pench Valley Coalfield. Exploration comprises mapping of 22 sqkm area on 1:10,000 scale and drilling of 5 boreholes to a cumulative depth of 2520.25 m (Two boreholes are in progress). Two boreholes were closed within Talchir Formation while one borehole was closed within Barakar Formation and two boreholes passed through Barakar Formation. Five regional Barakar coal seams (Seam-I to V in descending order), with cumulative thickness ranging from 15.35 m to 15.55 m, were intersected between the depths of 448.40 m and 589.25 m. Individual seam thickness showed variations from 0.69 m to 6.97 m. Seam IV was the thickest seam (5.85 m to 6.97 m) in the area. Seam-III generally was found to occur in two to three splits sections. The exploration will continue in field season 2019-20.
Base Metal							
Betul	South Western - part of Banskhapa Pipariya Sub block-I	-	-	10	1416.05	-	G-2 stage exploration over a strike length of 550 m was taken up to assess the base metal mineralisation in South Western part of Banskhapa-Pipariya Sub block-I. A total of 1,416.05 m drilling was done in 10 boreholes to check the depth persistence of mineralisation. Semi-massive to massive sphalerite ore with chalcopyrite and pyrite was found to occur within the garnetiferous-biotite-anthrophylite garnite schists. The disseminated mineralisation was seen manifested in the form of sphalerite, chalcopyrite, pyrite and a few pyrrhotite. Based on the analytical data of the boreholes, presence of mineralisation was established at vertical depth of 50 m, 100 m & 150 m over a strike length of 550 m with maximum values of 3.98% for Zn & 1.56%

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Table – 3 (contd)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
							for Cu in boreholes MPBBP-08 and MPBBP-01 respectively with consideration of minimum stoping width of 2.0 m.
REE (RM)							
Alirajpur	Motibar-Jetpur-Eran-Pangura area	1:12500	100	-	-	-	Reconnaissance survey for Rare Earth Elements (REE), Rare Metals (RM) mineralisation with associated tin and tungsten mineralisation in Motibar-Jetpur-Eran-Pangura area in Alirajpur district was carried out with Large-Scale Mapping of 100 sqkm on 1:12,500 scale. Result of REE in soil orientation survey showed REE concentration in top soil due to immobility. REE results for 36 BRS samples showed maximum total REE values of 776.8 ppm.
	Parts of Moriyagaon-Amba-Dareri-Sorwa area	1:12500	100	-	-	-	Reconnaissance survey was taken up for REE/ RM mineralisation with associated tin and tungsten mineralisation in Moriyagaon-Amba-Dareri-Sorwa Area in Alirajpur district, Madhya Pradesh and in parts of Chhota Udaipur District, Gujarat. Large-Scale Mapping on 1:12,500 scale was carried out in Moriyagaon-Amba-Dareri-Sorwa area in 100 sqkm area with sampling. Allanite, apatite and zircon were the REE-bearing phases in the rocks. The maximum value of total REE was 947 ppm and was associated with the alkali feldspar granite exposed nere NW of Village Doveri. A very small mineralised zone of manganese was noticed around Village Moriyagaon. The bedrock samples analysed Mn values of 19.6% and 4.0%.
Betul	Parts of Murha-Bhawargarh Fort-Nishana-Chopardhana areas	1:12500	200	-	-	510	Reconnaissance survey for REE and RM mineralisation in parts of Murha-Bhawargarh Fort-Nishana-Chopardhana areas, Betul district, comprised mapping of 200 sqkm area on 1:12,500 scale with collection of 200 bedrock samples, 150 soil samples and 100 pit &

(contd)

Table – 3 (contd)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
							trench samples (PTS) samples along with collection of 30 samples each for EPMA. SEM study was carried out to identify potential zones of REE and RM mineralisation. SEM-EDS and Electron probe studies (EPMA) showed presence of REE phases which is not in abundance. Xenotime, monazite, Nb-Ta phases were found as inclusions in tourmaline crystals within pegmatite. Allenite, apatite, epidote, titanite, yttrium-bearing zircon, plumbopyrochore, choukisite, calcite and garnet mineral phases were found in porphyroblastic gneiss, hornblende-biotite granite and pegmatites. The chemical analyses of 170 bedrock samples showed ∑ REE values ranging from 10.64 ppm to 1,686.60 ppm. The values of ∑LREE were found to vary from 9.96 ppm to 1,568.30 ppm while that of ∑HREE were found varying from 0.63 ppm to 148.5 ppm. The highest values of ∑REE was 1,686.6 ppm and that of ∑REY (REE+Y) was 1,964.64 ppm found at north-west of Bhawargarh Fort. Some sample of alkali syenites and hornblende biotite granites from north of Banka, Bhawargarh Fort, south of Pawahari and west of Chapra to south of Pawarjhanda Villages also showed >1,000 ppm ∑REE. They also were found to contain higher values of yttrium (Y) up to 341 ppm, niobium (Nb) up to 518 ppm, beryllium (Be) from <1 ppm to 1,022 ppm and strontium (Sr) up to 993 ppm. Higher values of lithium (Li) were found in NE-SW trending quartz reef (up to 700 ppm) located in the NW of Village Kantawari, small tourmalinite patch within pegmatite (0.12%) was located at SW of Village Murha and green microcline-bearing pegmatite veins (725 ppm) at extreme west of Village Banka.

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Table – 3 (contd)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
							One quartz-carbonate reef recorded high Rb values of 1,579 ppm. One stream sediment sample (SSS) from extreme west of Village Banka showed high ∑REE of 2,148 ppm. At the same locality a soil sample also show high ∑REE of 2,444 ppm. Majority of soil samples from south of Pawarjhanda and north of Banka Villages recorded moderate to high ∑REE (100.18 ppm to 1,899.66 ppm).
Shivpuri	Pichor block	1:12500	127	-	-	50	Reconnaissance survey for REE, tungsten, molybdenum and associated mineralisation in Pichor block, Shivpuri district involved mapping of 127 sqkm on 1:12,500 scale. A total of 75 cu. m. of trenching, 25 cu. m. of pitting and 50 number of soil samples were collected mostly in grid pattern from favourable location of REE enrichment. Bedrock samples (BRS) collected from lateritic capping around Village Rahi showed Cu values ranging from 185 ppm to 215 ppm and Ni values up to 105 ppm. REE analysis of 50 numbers of BRS samples showed total REE below 300 ppm except a few samples where in the range was from 455 to 523 ppm. Maximum total REE value of 523 ppm was observed from alteration zone developed at the contact of quartz reef and medium-grained granite around Village Khurai.
Chhatarpur	Basata and Kunwarpura area	1:12500	100	-	-	170	During reconnaissance survey for Rare Metal (Zr-Y-Nb) and REE mineralisation in parts of Bundelkhand Granitoid Complex (BGC) in Basata and Kunwarpura area, Chhatarpur district, Large-Scale Mapping of 100 sqkm on 1:12,500 scale along with 50 cu. m pitting & trenching and collection of 100 BRS, 50 PTS and 10 each for petrological, petrochemical, Ore-microscopy and EPMA studies were carried

(contd)

Table – 3 (contd)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
							out. Two alkaline dykes of syenitic composition were located, one north of Village Raipura which traced for a length of 50 m with width up to 20 m and the other alkaline body located NNE of Village Kunwarpura showed width up to 3 m and length up to 30 m. Analytical results of alkaline dykes showed encouraging ∑REE values from 522 ppm to 1,314 ppm. The average ∑REE values was 768 ppm. ∑LREE showed variations from 506-1,285 ppm while ∑HREE seemed to vary from 12 to 38 ppm. This dyke also showed ∑REE at 456-1,310 ppm in 10 pit & trench samples (PTS).
Diamond							
Panna and Chattarpur	Ajaygarh block	-	-	-	-	-	Reconnaissance survey for Kimberlite/Lamproite was taken up in Ajaygarh block in parts of Panna and Chattarpur districts, Madhya Pradesh and Banda district of Uttar Pradesh. A pyroxenite body was identified in Bhawanipur of Ajaygarh block intruded in the medium-grained granite of Bundelkhand Granite Complex. A suspected diamond grain of 2 mm size was identified as Kimberlite indicator mineral from the sample collected from Village Kauhari. SEM EDX study of the grain confirmed that it is a gem quality diamond without any inclusion. Further SEM image of diamond showed that the edges of the diamond were sharp with solid angles with elongated and pyramidal hillocks, etc. which indicates its proximal primary source.
	Bariyarpur block	-	-	-	-	-	Reconnaissance survey for Kimberlite/ Lamproite was taken up in Bariyarpur block in parts of Panna and Chattarpur districts, Madhya Pradesh and Banda district of Uttar Pradesh. In the Bariyarpur block, both ultramafic and mafic

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Table – 3 (contd)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
							dykes were identified. Kimberlite indicator minerals (KIMs) like pyrope garnets, ilmenites, spinels, phlogopites and micro diamonds were recovered during Heavy Mineral Studies (HMS) of stream sediment samples. Moissanite, a very rare naturally occurring silicon carbide mineral has also been found during HMS which indicates proximal source of diamondiferous kimberlite. This rare mineral was reported for the first time in Panna Diamond Belt. Kimberlitic affinities of pyrope garnets, ilmenites, spinels, phlogopites later were confirmed by EPMA studies. Overall, the presence of positive KIMs as an indication of a proximal primary source rock. During field traverse, suspected altered lamproitic rock observed in north-west of was River Ken.
Gold							
Singrauli	Budhadol-Sulkhan area	1:12500	100	-	-	-	During G4 stage survey for gold and associated sulphide mineralisation, an area of 100 sqkm area was mapped on 1:12,500 scale. Mineralisation mostly noticed in smoky and mixed quartz veins and at some places white quartz veins showed good evidences of mineralisation. Mineralisation in quartz veins was found to occur in the form of pyrite, chalcopyrite, galena, arsenopyrite, malachite and pyrrhotite as vug or fracture filling within the quartz veins. Besides Large-Scale Mapping, bedrock samples, petrochemical samples, petrological samples, EPMA and pitting/ trenching samples were also collected for chemical analysis. Pitting/trenching was carried out in ferruginous phyllite, quartzite and quartz vein to find subsurface indications of mineralisation. An aerial reconnaissance and PGRS study of 700 sqkm. area was carried out to reveal the presence of altered clay minerals.

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Table – 3 (contd)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
Sidhi	Dudhmania block	-	-	-	-	-	During reconnaissance survey for gold, REE and associated mineralisation, various litho-units that were demarcated in the area included sulphidic chert bands, BIF bands inter-banded with phyllite, green colour khaki phyllites, tuffaceous phyllites, ferrugenous phyllite, greywacke/ quartzwacke interbanded with phyllite, biotite schist, metabasalt and intrusives in the form of dykes (Meta dolerites/ Metagabbro) and quartz veins. Pyrite, chalcopyrite and arsenopyrite were noticed as fracture fillings within sulphidic chert and BHC near Village Jardha. Disseminated grains of pyrite, chalcopyrite, galena and arsenopyrite were observed within BHC and small quartz veins near Bagdari, Siyari, Chelwa, Gidher Village. Quartz vein containing stains of malachite, grains of galena and arsenopyrite was observed near Village Parihasi. Sulphide mineralisation was mainly in the form of disseminated grains and specks in quartz veins and at few places in smoky quartz veins near Village Majhigawan. Chalcopyrite and pyrite were seen in Bandar Ghori, east of Village Pokhra, SW of Village Jurni and near Village Majhigawan. Mafic bodies were mainly of two types, i.e., one is parallel to bedding and the other that shows cross cutting with host rock and that are mineralised.
Singrauli	Around Birkuniya – Barawani – Chatri area						Large-Scale Mapping of 100 sqkm was carried out to delineate mineralised zones for gold and iron bands. Demarcation of sulphide minerals-bearing smoky quartz veins was done along with iron bands within the banded ferruginous chert/ quartzite and magnetite bands in BMQ. The sulphide mineralisation was observed mainly in smoky quartz veins and as well as in chert band

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Table – 3 (contd)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
							and other intrusives. The occurrence of sulphides was sporadic and scattered within the rock. They were mainly arsenopyrite, chalcopyrite and pyrite. The mineralised quartz veins were primary and smoky in nature whereas the milky ones were secondary and non-mineralised.
Gluconite							
Singrauli	Bardi block Chitrangi Tehsil	1:12500	2.0	-	602.45	52	G3 stage preliminary investigation for glauconitic shale/sandstone was taken up. Thin bands of glauconitic shale/limestone were noticed within the green/grey shale and fawn limestone. The glauconitic shale/limestone was bluish-green in colour. In Bardi block, dark bluish-green colour, sub-rounded to rounded pellets of glauconite were clearly visible in coarse-grained glauconitic sandstone. These pellets were also seen to form thin laminations in fine to medium-grained sandstone. Glauconite grains/ pellets of bluish-green colour were notied in fawn limestone. Thin bands of glauconitic shale were noticed within the green/ grey shale and whitish grey clayey shale. Three modes of occurrences of glauconite were reported in the mapped area. i) Thin lamination: Bluish-green coloured glauconitic laminations were noted in glauconitic shale, fine to medium-grained sandstone and intercalated whitish grey clayey shale-pale green shale. ii) Inter-granular space filling: in coarse-grained glauconitic sandstone, glauconitic grains were seen to occur as inter-granular grains between quartz grains. In limestone, bluish-green colour glauconite grains were seen associated with allochem. iii) Fracture filling: Fracture filled bluish-green colour glauconite was noticed in limestone. The analytical results of 34 core samples collected from two

(contd)

Table – 3 (contd)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
							boreholes showed encouraging value for K_2O concentration ranging from 5.04 to 9.57%, while 18 BRS samples showed K_2O values varying from 6.04 to 11.27%.
Graphite							
Alirajpur	Juwari Bari-Chhoti-Rampura-Jorbat area	1:12500	108.0	-	-	237	G4 stage reconnaissance survey in the area included Large-Scale Mapping, collection of 106 bedrock/channel samples and 105 PT samples for search of graphite mineralisation, 26 BRS for base metal analysis and geophysical survey (IP, SP, Magnetic and Resistivity) of about 14.19 L km area. During mapping, three separate discontinuous zones were demarcated: i) The eastern zone, having a cumulative length of about 900 m with width varying from 13 m to 24 m was exposed discontinuously from Betwasa in the south up to Kosduna in the north. A trench showed 18 m thick mineralised zone having 2.90% average fixed carbon values at 2% cut off, ii) The central zone was discontinuously exposed from Dehdala to west of Rampura over a cumulative strike length of about 2.7 km with thickness varying from 8 m to 22 m. The trench and channel samples indicated 7 m to 16 m thick graphite-bearing zones with average fixed carbon value varying from 1.18% to 2.13% at 2% cut off and iii) The western zone from Chamarbegra to Juwari Bari was discontinuously exposed over a cumulative length of 3.70 km with width varying from 5 m to 30 m. It shows 2.72% and 4.55% average fixed carbon values at 2% cut off in trench and channel samples with width varying from 5 m to 9 m. To the northeast of Juwari Bari, a separate thick carbon phyllite/ graphite schist associated with grey carbonaceous marble was demarcated having a length of about 1.65 km and width of about

(contd)

Table – 3 (contd)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
							160 m. Five grab/spot samples from this band indicated fixed carbon values ranging from 3.08% to 16.88%. Apart from graphite mineralisation, a sheared quartz vein with a length of about 1.25 km and width of 10-20 m showing evidences of copper mineralisation in the form of malachite staining, small specks of chalcopyrite and chalcocite also were recorded in the east of Kosduna. Out of 03 samples, 1 spot/grab sample indicated 1.45% copper.
	Netara-Khattali Bari-Phata Dam area	1:12500	100.0	-	-	178	A G4 stage reconnaissance survey was taken up in the area which included collection of 77 bedrock/ channel samples, 101 PTS and 25 BRS for base metal analysis. Geophysical survey (IP, SP, Magnetic and Resistivity) of about 11.2 L km area in prospective areas was carried out for graphite mineralisation. During mapping, two main separate discontinuous graphite-bearing zones were recorded in carbon phyllite associated with grey phyllite. The eastern mineralised zone recorded near Village Netara was about 8 m to 25 m in thickness and the cumulative strike length was of about 1.5 km. The trenches in this area indicated two to four graphite mineralisation of width varying from 1 m to 12 m. The analytical results of BRS showed fixed carbon value varying from <1% to 15.8% and in trench samples from <1 % to 11%. In the western graphite-bearing area in south to SE of Village Jamani, two separate closely spaced linear zones of graphite schist/carbon phyllite were traced for a cumulative strike length of over one km with width varies from a few meters to 10 m. The BRS in Jamani area showed the fixed carbon content to be ranging from <1% to 9.61%. The graphite schist /carbon phyllite in the east of Village Kherwa recorded a cumulative strike length of over 700 m with thickness ranging from 4 m to 10 m.

(contd)

Table – 3 (contd)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
Betul	Golighat-Makra block	1:2000	1.25	21	1746.3	-	Under G-3 stage of investigation, an area of 1.25 sqkm, (1.15 sqkm in Golighat-Makra main block and 0.10 sqkm in Junawani block) was mapped on 1:2,000 scale. Geophysical survey in western part of the Golighat-Makra main block was carried out in continuation of geophysical survey in Golighat area (which was covered during FS 2017-18) to evaluate the extent and potential of graphite mineralisation. The IP/resistivity survey in Golighat-Makra main block was intended to help in delineating host rock and to assess the extent of graphite mineralisation in soil cover areas. The graphite schist associated with quartz mica schist was found to occur as enclaves within the granite/granite gneiss. A total of 1,746.30 m of drilling in 21 boreholes (comprising 09 first, 06 second and 01 third-level borehole in Golighat area, 02 each first and second-level boreholes in Makra area and 01 first-level borehole in Junawani area) were carried out. The boreholes were drilled at 200 m interval and mineralisation was targeted to be intersected at 30 m, 60 m and 90 m vertical depth in 1st, 2nd and 3rd level boreholes, respectively. All boreholes except one borehole intersected two to three zones of graphite mineralisation of various thicknesses. The width of mineralised zones was found to vary from 0.50 m to 17.30 m along the borehole. The subsurface data indicated that the width of mineralised zone showed variations along the strike as well as depth and exhibited pinching and swelling nature. The graphite mineralisation in Golighat area was found to occur as two separate lenses of 800 m and 600 m strike length with cumulative strike length of 1,400 m. In Makra area, the strike length of graphite-
	Junawani block	1:2000	0.10				

(contd)

Table – 3 (contd)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
							bearing mineralised zone was about 300 m and was seen to continue further east. The chemical analysis results received so far indicated that the average fixed carbon value in the intersected mineralised zones was observed to vary from 1.21% to 12% in Golighat area and 1.71% to 11.90% in Makra area. In Junawani area, only one borehole was drilled and two very thin mineralised zones of 0.40m and 1.10 m only were intersected. The strike length of graphite schist was only 90 to 100 m. Therefore, no further drilling was carried out in Junawani area. The subsurface drilling data indicated that the host rock for graphite mineralisation was graphite-bearing quartz mica schist intruded by granite along the foliation planes. Largely the graphite-bearing bands are found in association with granite/granite gneiss and sometimes as interbands within the quartz mica schist. Shearing was observed to be dominant in the eastern part of Golighat-Makra main block where graphite mineralisation was found to be associated with brecciated cherty granite and graphite was also remobilised along fracture planes. The graphite noticed as grey to greyish-black in colour was soft, greasy, schistose and flaky in nature. Small flakes of steel grey graphite were seen mixed intimately with muscovite flakes and ash grey powdery material in the graphite schist. Based on the work carried out under G3 stage of investigation, the item was seamlessly upgraded to the G2 stage of exploration in Golighat block. The study is to continu as spillover of FS 2019-20.
Limestone							
Katni & Satna	Jamuwanikala block & Bhatia limestone block	1:4000	0.48	12	644.15	-	A G2 stage general exploration for limestone and bauxite involved detailed mapping of 0.48 sqkm on 1:4,000 at both Jamuwanikala and Bhatia limestone blocks along

(contd)

Table – 3 (contd)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
							with drilling (644.15 m) and other connected sampling. Jamuwanikala block for limestone and bauxite covered an area of about 0.23 sqkm. In this block, 4 boreholes were drlled to a cumulative depth of 304.05 m. Jamuwanikala block was seen represented by grey-bluish to grey coloured, well-bedded limestone intercalated with shale. Southern margin of block was represented by Rohtashgarh limestone. A total of 8 boreholes were drilled to a cumulative depth of 340.10 m in Bhatia limestone block (0.25 sqkm). Bhatia block was observed to be mainly represented by light gray to dark gray, moderately hard, fractured and stromatolitic limestone. Carbonate vein of 0.5-1 cm was present at various depths.
MECL							
Base Metal							
Shivpuri	Mohar Cauldron area	1:12500	100	-	-	177	A G4 level exploration for base metal and gold was taken up in Mohar Cauldron area, Shivpuri district. Exploration work comprised remote sensing study of 100.00 sqkm, geological mapping on 1:12500 scale and collection of 91 bedrock samples, 86 stream & soil samples. These samples were analysed for Cu, Pb, Zn, Au, Ag, REE, U, Mo and W. Analysis of bedrock samples showed Cu values ranging from < 1.0 ppm to 242.0 ppm, Pb values from 13.91 ppm to 41.14 ppm, Zn values from 10.17 ppm to 129.80 ppm, Au value as < 0.1 ppm, Ag values from <0.1 ppm to 0.3 ppm, U values from 1.42 ppm to 20.53 ppm and REE total values from 63.97 ppm to 359.34 ppm. The granite showed REE total values from 63.97 ppm to 359.34 ppm, while andesite showed 114.09 ppm to 227.45 ppm and rhyyolite showed 129.78 ppm to 352.14 ppm.

(contd)

Table – 3 (concld)

Agency/ Mineral/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
HCL							
Base Metal							
Balaghat district	Malanjkhand copper mine	-	-	10	1950.85	-	Exploration in Malanjkhand copper mine, Balaghat district, Madhya Pradesh was carried out to find out extent of ore body for dimension of stope and grade for underground mining. A total 1950.85 meterage were drilled in 10 boreholes. Resources estimated of the mine are placed at about 308.45 million tonnes with average grade of 0.92% Cu.

Table – 4 : Mineral Production in Madhya Pradesh, 2016-17 to 2018-19 (Excluding Atomic Minerals)

(Value in ` '000)

Mineral	Unit	2016-17			2017-2018			2018-19 (P)		
		No. of mines	Quantity	Value$	No. of mines	Quantity	Value$	No. of mines	Quantity	Value$
All Minerals		**219**		**51614133**	**227**		**78042284**	**213**		**82281327**
Coal	'000t	-	105013	-	-	112127	-	-	118661	-
Natural Gas (ut.) +	m c m	-	7	-	-	200	-	-	357	-
Bauxite	t	20	676478	543776	19	593633	442907	20	722549	577694
Copper Ore	t	-	2415330	-	-	2339035	-	-	2542159	-
Copper Conc.	t	1	68187	3128301	1	75605	3486098	1	82945	4549382
Iron Ore	'000t	17	1771	767339	15	2743	1239712	18	2792	1449207
Manganese Ore	t	48	650316	4532518	42	837041	6760106	40	944207	7820952
Phosphorite	t	4	149700	129033	4	113947	108783	4	98600	79296
Diamond	ct	2	36491	639562	2	39699	374110	2	38437	581058
Limestone	'000t	127	36164	8405039	144	43060	10779367	128	49762	10763488
Minor Minerals		-	-	33468565	-	-	54851201	-	-	56460250

***Note**: The number of mines excludes fuel and minor minerals.*
$ Excludes the value Fuel minerals. + Coal Bed Methane

Table – 5 : Principal Mineral-based Industries

Industry/plant	Capacity ('000 tpy)
Aluminium/Alumina	
Hindalco Industries Ltd, Mahan Aluminium, Bargwan, Distt Singrauli	360 (Aluminium)
Asbestos Products	
Everest Building Products Ltd, Kymore	NA
Kalani Industries Pvt. Ltd, Pitampur, Dhar	NA
Ramco Industries Ltd, Maksi, Distt Shajapur	NA
Calcined Lime	
Rekha Harlalka, Jukehi, Maihar	11
Padampani Tripathi, Mamalime Industries Rajarwara, Katni	9.6
Cement	
ACC Ltd, Kymore, Distt Katni	2720
Bhilai Jaypee Cement Ltd, Babupur, Satna	1300
Birla Corpn. Ltd, (Satna Cement Works & Birla Vikas Cement), Satna	2200
Birla Coorporation Ltd, (Erstwhile Reliance Cement Pvt. Ltd, Maihar, Distt Satna	3000
Century Textiles & Ind. Ltd, Maihar Cement, Maihar (unit I&II), Distt Satna	4200
Heidelberg Cement (I) Ltd, Narsingarh, Distt Damoh	2000
Jaiprakash Power Ventures, Singrauli (G)	2000
Jaypee Rewa Cement Plant, Distt Rewa	2500
Jaypee Bela Cement Plant, Distt Rewa	2600
KJS Cement, Rajnagar, Distt Satna	2200
Prism Cement Ltd, (Unit I & II), Satna	6600
Satguru Cement Pvt. Ltd, Ghursal, Gandhawani	95
UltraTech Cement Ltd, Sidhee	2300
UltraTech Cement, Dhar Cement Plant, Tonki, Temarni sounul, Golpura Manawar	3500
UltraTech Cement, Vikram Cement Plant, Khor, Distt Neemuch	4500 (OPC) 4500 (PPC)
UltraTech Cement Ltd, Majhigawan, Rampur Naikin	3000
Ceramic	
Roca Bathroom Products Ltd, Dewas	NA
Govind Tiles Pvt. Ltd, Garra, Distt Balaghat	NA
Calcined lime	
Som lime work, Jukehi, Katni	21.6
Jai Mata lime Industries Pathra, Katni	15.2
Dharampal Industries Pathra, Katni	6
Sampuran Singh Saluja Patra, Katni	6.07

(Contd.)

Table-5 (concld)

Industry/plant	Capacity ('000 tpy)
Fertilizer	
Agro Phos. (India) Ltd, Dewas	45 (SSP)
Arihant Ferts. & Chems. India Ltd, Kanawati, Neemuch	66 (SSP)
Basant Agro Tech (India) Ltd, Jawad, Neemuch	45 (SSP)
Coromandel International Ltd, (Formerly, Liberty Urvarak Ltd,), Nirmani Khargone	100 (SSP)
Indra Industries Ltd, (Formerly, Swastik Ferts & Chems Ltd,), Indore, Dhar	66 (SSP)
KMN Chemicals & Fertilizers Ltd, Diwanganj, Raisen	60 (SSP)
Khaitan Chemical & Fertilizers Ltd, Nimrani, Distt Khargone	400 (SSP) 115.5 (H_2SO_4)
NFL, Vijaipur (Unit I & II), Distt Guna	2066.1 (Urea)
Krishna Phoschem Ltd, Meghnagar, Jhabua	120 (SSP)
Madhya Bharat Agro Products Ltd, Rajoa, Sagar	60 (SSP)
Madhya Bharat Phosphate Pvt. Ltd, (Unit I), Diwanganj, Sanchi, Raisen	132 (SSP)
Madhya Bharat Phosphate Pvt. Ltd, (Unit II), Meghnagar, Jhabua	165 (SSP)
Mexican Agro Chemical Ltd, (Formerly, Asha Phosphates Ltd,), Jaggakhedi, Mandsaur	60 (SSP)
Mukteswar Fertilizers Ltd, Narayankhedi, Ujjain.	60 (SSP)
Rama Phosphates Ltd, Indore	250 (SSP) 102 (H_2SO_4)
Suman Phosphates and Chemicals Ltd, Indore	330 (SSP)
Varun Fertilizers Pvt. Ltd, Dewas	100 (SSP)
Ferroalloys	
Crescent Alloys Pvt. Ltd, Seoni	4.5
Jalan Ispat Castings Ltd, Meghnagar, Distt Jhabua	12
MOIL Ferro Manganese Plant, Bharveli, Distt Balaghat	10
Petroleum Refinery	
Bharat Oman Refineries Ltd, Bina, Distt Sagar	6000
Refractory	
ACC Refractories, Katni	65
Calderys India Refractories Limited	78
Katni Refractory Works, Katni Murwara	30 (Binder) 9 (Grout)
Mahakoshal Refractories Pvt. Ltd, Katni	61.09
Mahakoshal Refractories Pvt. Ltd, Gudri, Bohariband	31
Premier Refractories India Pvt. Ltd, Katni.	50

G; Grinding Unit

Note: *Data not readily available for fertilizer and cement industries on respective websites, is therefore taken from Indian Fertilizer Scenario, FAI Statistics and Survey of Cement Industry & Directory, respectively.*