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(Part- III : Mineral Reviews)

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MINOR MINERALS

**30.20 QUARTZ & OTHER SILICA
MINERALS**

[MOULDING SAND, FLINTSTONE (MAJOR)]

(ADVANCE RELEASE)

**GOVERNMENT OF INDIA
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30-20 Quartz & Other Silica Minerals

The term 'quartz' is often referred to as a synonym for silica. Silica is one of the ubiquitous materials in the earth's crust. Quartz, quartz crystals, quartzite, silica sand, sand (others) and moulding sand are all coined together in one generic name 'silica minerals'. This is because all these commodities are essentially crystalline silicon dioxide (SiO_2) with variations mostly related to their crystalline structure and presence of minor or trace impurities. Silica occurs in several forms giving rise to different varieties.

Crystalline Varieties

The important varieties of crystalline quartz are vein quartz (massive crystalline quartz); milky quartz (white, translucent to opaque); ferruginous quartz (containing brown limonite and red haematite and almost opaque); aventurine quartz (containing glistening flakes of mica or haematite); cat's eye (opalescent greenish quartz with fibrous structure); rock crystal (clear, colourless, well-crystallised transparent quartz); amethyst (clear-purple or violet-blue), transparent quartz; rose quartz; smoky quartz; etc. Occurrences of massive crystalline quartz in veins or pegmatites have been recorded in almost all the States.

Clastic or Granular Varieties

These varieties include sand consisting largely of unconsolidated quartzose grains (0.06 mm to 2 mm diameter), gravel consisting largely of unconsolidated coarse quartzose grains or pebbles (2 mm to 8 mm in diameter), sandstone and quartzite. Quartzite is a granulose metamorphic rock consisting essentially of quartz and sandstone cemented by silica which has grown in optical continuity around each grain. Occurrences are reported from Andhra Pradesh, Bihar, Delhi, Haryana, Karnataka, Kerala, Madhya Pradesh, Rajasthan, Tamil Nadu, Uttar Pradesh, etc. The silica sand from Naini area in Allahabad district, Uttar Pradesh is of a very high quality.

Cryptocrystalline Varieties

This group includes chalcedony, agate, jasper, onyx, flint and chert. These varieties appear non-crystalline (amorphous) in hand specimens, but under microscope show double refraction which reveals their concealed crystalline nature. These varieties are reported from Gujarat, Uttar Pradesh, Tamil Nadu, Andhra Pradesh, Maharashtra, Madhya Pradesh, Karnataka and Punjab. The most important occurrences of agate are in Ratnapur, Rajpipla area and further west between Rivers Tapi and Narmada in Bharuch district, Gujarat, where it is found as pebbles in varying sizes associated with clay washed down by the river flow. Other occurrences of economic importance are reported from Amravati, Aurangabad, Buldhana, Chandrapur, Nashik and Pune districts in Maharashtra; beds of Rivers Krishna and Godavari in Andhra Pradesh; Dumka district in Jharkhand; Dhar, Mandsaur, Sihore and Shahdol districts in Madhya Pradesh; and Kachchh district in Gujarat.

As per Govt of India Gazette Notification S.O. 423 (E), dated 10th February 2015, 31 minerals have been declared as minor minerals. Out of these 31 minor minerals, agate, fuschite quartzite, jasper, quartz, quartzite, sand (others) and silica sand come under the different variety of silica minerals. Minor minerals come under the purview of respective State Governments and they frame the rules for minor minerals.

RESERVES/RESOURCES

As per the NMI database, based on UNFC system as on 1.4.2015, the total reserves/resources of quartz and silica sand in the country has been estimated at 3,907.95 million tonnes out of which 647.53 million tonnes (17%) are placed under Reserves category and 3,260.42 million tonnes (83%) are placed under Remaining Resources category. Resources by grades reflect Foundry & Moulding grade at 735.59

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million tonnes (19%), Glass at 649.71 million tonnes (17%), Ceramic & Pottery grade at 438.44 million tonnes (11%) and Ferro-silicon grade at 183.96 million tonnes (5%). The Abrasive, Sodium silicate, Others, Unclassified and Not-known grades account for 1,900.18 million tonnes (48%) of the total resources. Statewise, Haryana alone accounts for 1,653.65 million tonnes (42%) of the total resources, followed by Rajasthan at 740.46 million tonnes (19%), Andhra Pradesh 236.69 million tonnes (6%), Tamil Nadu 201.49 million tonnes (5%), Maharashtra 179.72 million tonnes (4.60%), Jharkhand 151.19 million tonnes (4%), Uttar Pradesh 140.72 million tonnes (3.60%), Gujarat 132.42 million tonnes (3.39%), Kerala 128.48 million tonnes (3.28%), Karnataka 95 million tonnes (2.43%), Telangana 80.07 million tonnes (2.05%) etc. (Table-1).

Similarly, the total reserves/resources of quartzite in the country as per NMI database, based on UNFC system as on 1.4.2015 has been estimated at 1,658.80 million tonnes out of which Reserves are placed at 83.47 million tonnes (5%) and the Remaining Resources at 1,575.32 million tonnes (95%). Statewise bulk resources of about 884.18 million tonnes are located in Haryana (53%) followed by Bihar 277.82 million tonnes (17%), Odisha 140.55 million tonnes (8.47%), Maharashtra 90.70 million tonnes (5.46%), Punjab 81.91 million tonnes (5%) and Jharkhand at 40.70 million tonnes (2.45%). Gradewise resources of Refractory grade-I & II are estimated at 579.45 million tonnes (35%), Ceramic & Pottery grade at 215.91 million tonnes (13%), BF grades at 66.50 million tonnes (4%) and the remaining resources of 796.92 million tonnes (48%) are of Ferro-Silicon, low, Unclassified, Others & Not-known grades (Table-2).

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

Quartz/Silica Sand/Quartzite/Sand (Others)/Agate

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'quartz/silica sand/quartzite/sand (others)/ agate/ jasper' have been declared as 'Minor Mineral', hence the producers report the

production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few States could be collected. All possible information/data that could be gathered has been presented in this Review.

Statewise production of quartz, silica sand, quartzite during 2019-20 to 2021-22 is furnished in Tables-3 to 5.

Table-3: Statewise Production of Quartz

State	(In tonnes)		
	Year		
	2019-20	2020-21	2021-22
Rajasthan	5744000	3037988	2799048
Andhra Pradesh	878270	547390	-
Telangana	813816	-	-
Gujarat	-	-	-
Maharashtra	245050	-	-
Karnataka	127064	71020	-
Odisha	148	2589	1458

Source: As received from State DGMs and their websites.

Note: " - " NA

Table-4: Statewise Production of Silica Sand

State	(In tonnes)		
	Year		
	2019-20	2020-21	2021-22
Gujarat	-	-	-
Andhra Pradesh	2871070	1402110	-
Rajasthan	1329000	1306802	1948690
Maharashtra	879007	-	-
Himachal Pradesh	1500	-	7613
Kerala	-	-	-

Source: As received from State DGMs and their websites.

Note: " - " NA

Table-5: Statewise Production of Quartzite

State	(In tonnes)		
	Year		
	2019-20	2020-21	2021-22
Andhra Pradesh	525726	851897	-
Gujarat	-	-	-
Rajasthan	17000	120079	-
Odisha	72352	86668	173813

Source: As received from State DGMs and their websites.

Note: " - " NA

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**Table – 1 : Reserves/Resources of Quartz & Silica Sand as on 1.4.2015
(By Grades/States)**

Grade/State	Reserves										Remaining Resources					Total Resources (A+B)
	Proved STD111	Probable		Total (A)	Feasibility STD211	Pre-feasibility		Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)				
		STD121	STD122			STD221	STD222									
All India: Total	433014	93339	121169	647522	354566	368217	362128	36872	219180	1897899	21436	3260297	3907819			
By Grades																
Glass	205934	24780	19173	249886	83708	46000	54870	3268	5506	194962	11505	399820	649706			
Ferro-silicon	10385	170	6729	17283	14199	15950	15194	106	65173	55878	179	166679	183963			
Sodium silicate	2385	80	1911	4376	840	1422	5313	195	325	30869	11	38976	43351			
Ceramic and Pottery	35142	8883	23348	67373	98139	24681	68351	7553	13022	159035	289	371070	438443			
Foundry and Moulding	115324	4946	9898	130167	71962	47190	121130	19234	37977	300257	7672	605421	735589			
Abrasive	48	-	-	48	2253	256	1984	22	21	3508	-	8043	8091			
Others	20911	8067	2026	31004	44667	65197	27456	1185	873	866706	541	1006625	1037629			
Unclassified	42010	45825	56370	144204	28474	161250	48346	4747	1976	150383	679	395855	540060			
Not-known	875	590	1715	3180	10323	6270	19485	563	94307	136301	560	267808	270988			
By States																
Andhra Pradesh	94483	3429	13687	111599	32690	4039	17329	7081	6691	45661	11599	125090	236690			
Assam	-	-	-	-	-	-	-	-	-	1790	-	1790	1790			
Bihar	-	-	-	-	-	-	-	-	-	25755	-	25755	25755			
Chhattisgarh	501	479	800	1780	389	282	789	56	26	642	7672	9856	11636			
Goa	-	-	-	-	-	20	1736	-	-	18248	-	20004	20004			
Gujarat	27892	5617	15260	48769	26742	6681	17809	2932	3371	26099	21	83656	132425			
Haryana	-	-	-	-	35553	247695	186475	886	642	1182400	-	1653650	1653650			
Himachal Pradesh	1	-	7	8	99	-	-	-	-	2928	-	3027	3035			
Jammu & Kashmir	-	-	-	-	-	-	-	-	-	3110	-	3110	3110			
Jharkhand	-	-	1070	1070	534	985	4533	137	766	143053	112	150122	151192			
Karnataka	7975	417	1807	101991	15904	6695	9448	94	52	52077	525	84794	94993			
Kerala	221	33	136	389	179	1985	3588	14611	30241	77489	-	128092	128481			
Madhya Pradesh	129	30	1781	1940	516	-	920	791	316	2717	-	5261	7201			
Maharashtra	15188	93	9984	25265	33039	15455	48535	-	355	57077	-	154461	179726			
Meghalaya	-	-	-	-	-	-	-	-	177	6906	-	7083	7083			
Odisha	567	109	725	1401	344	2038	2918	93	63308	3944	179	72824	74225			
Punjab	-	-	-	-	-	-	-	-	-	3927	-	3927	3927			
Rajasthan	239131	58049	51713	348894	160210	34587	50216	5464	8001	131753	1098	391439	740333			
Tamil Nadu	25086	3493	1199	29778	28196	15176	2191	3387	95837	26931	-	171718	201496			
Telangana	18541	1367	6916	26824	10334	2414	8365	159	3107	28642	230	53250	80074			
Tripura	-	-	-	-	-	-	-	225	-	264	-	490	490			
Uttar Pradesh	445	19825	15144	35413	9415	30013	7048	957	6290	51590	-	105314	140727			
West Bengal	2853	400	939	4193	310	151	229	-	-	4896	-	5586	9779			

Figures rounded off.

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**Table – 2 : Reserves/Resources of Quartzite as on 1.4.2015
(By Grades/States)**

Grades/States	Reserves						Remaining Resources						Total Resources (A+B)
	Proved STD111	Probable		Total (A)	Feasibility STD211	Pre-feasibility		Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	
		STD121	STD122			STD221	STD222						
All India : Total	47758	2016	33698	83472	120723	141437	160355	119953	152715	868850	11293	1575325	1658798
By Grades													
Refractory Grade-I	29574	831	19192	49597	50814	10512	31337	1032	1067	293813	2906	391482	441079
Refractory Grade-II	1038	303	42	1384	1666	3220	497	3183	21075	99849	7497	136987	138371
Ceramic / Pottery	112	49	16	177	18499	37356	58442	-	3599	97772	72	215741	215918
Low	249	35	-	284	2139	3764	73	-	23	8791	-	14789	15073
Ferro-silicon	-	-	-	-	169	8392	3034	-	376	461	523	12955	12955
B.F.	-	-	-	-	-	848	2067	197	275	62822	295	66503	66503
Others	9713	68	175	9956	35277	15920	2093	309	251	44895	-	98745	180701
Unclassified	5572	672	12938	19182	12158	55006	60718	94298	94799	226394	-	543373	562555
Not-known	1500	58	1334	2892	-	6418	2094	20935	31250	34053	-	94750	97642
By States													
Andhra Pradesh	16001	-	1389	17390	2103	8357	6418	-	3975	24797	1256	46905	64295
Arunachal Pradesh	-	-	-	-	-	-	-	-	-	5270	-	5270	5270
Bihar	-	282	12260	12542	390	959	8090	5490	22822	227531	-	265282	277824
Chhattisgarh	605	1524	1567	3696	575	7035	1856	-	-	15404	-	24870	28566
Haryana	-	-	-	-	50751	118056	116686	113902	124458	360335	-	884188	884188
Himachal Pradesh	25	-	16	41	16	-	-	-	-	-	-	16	57
Jammu & Kashmir	1500	58	-	1558	-	-	-	-	120	9100	7380	16600	18158
Jharkhand	181	-	-	181	763	49	390	197	275	38854	-	40527	40708
Karnataka	231	-	-	231	69	48	592	-	-	4914	1730	7353	7584
Madhya Pradesh	-	-	-	-	-	-	-	-	-	832	-	832	832
Maharashtra	9026	-	-	9026	49172	-	21156	-	-	11344	-	81671	90697
Odisha	20050	151	18381	38582	16861	6914	5128	364	274	71503	927	101971	140554
Punjab	-	-	-	-	-	-	-	-	116	81796	-	81912	81912
Rajasthan	140	-	86	226	-	18	18	-	-	706	-	742	968
Sikkim	-	-	-	-	-	-	-	-	675	16444	-	17119	17119
West Bengal	-	-	-	-	24	-	21	-	-	21	-	66	66

Figures rounded off.

Moulding Sand

The production of moulding sand was Nil tonnes in 2021-22 as against 11,737 tonnes in the previous year.

There were four reporting mines in the year 2020-21 against three reporting mines in 2019-20. The production of moulding sand was reported only from Chhattisgarh State during the year (Table -6 to 8).

Flint Stone

The production of flint stone was not reported since last three years i.e. 2019-20 to 2021-22.

MINING

Mining for silica minerals is carried out by manual opencast method. Quartz produced in the form of lump along with other associated minerals is invariably hammered to pieces and manually sorted before it is despatched to the consuming industries. It is sometimes crushed and marketed. Glass sand is generally screened and washed to remove all the deleterious constituents for its use in Glass Industry.

APMDC owns two crushing plants located at Mahabubnagar district in Andhra Pradesh with crushing capacity of 45 tonnes and 1,000 tonnes a month, respectively. Besides, Maharashtra Minerals Corp. Ltd operates a 50,000 tonnes per year

Table - 6: Principal Producers of Moulding Sand, 2020-21

Name and address of producer	Location of mine	
	State	District
Mahendra Kumar Seksaria, 271, Ramdev Mandir, Ward-35, Ganjpara, Durg-491 001, Chhattisgarh.	Chhattisgarh	Durg
Smt. Sujata Dakaliya, House No: 19/132, Sahadeo Nagar, Rajnandgaon-491 441, Chhattisgarh.	Chhattisgarh	Rajnandgaon
Bimal Kumar Seksaria, 271, Ramdev Mandir, Ward-35, Ganj Para, Durg- 490 001, Chhattisgarh.	Chhattisgarh	Rajnandgaon

Table -7: Production of Moulding Sand, 2019-20 to 2021-22 (By State)

(Qty in tonnes; Value in `J'000)

State	2019-20		2020-21		2021-22	
	Quantity	Value	Quantity	Value	Quantity	Value
India	12805	3683	11737	3419	-	-
Chhattisgarh	12805	3683	11737	3419	-	-

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**Table – 8 : Production of Moulding Sand, 2019-20 & 2020-21
(By Sector/State/Districts)**

(Qty in tonnes; Value in `J'000)

State/District	2020-21			2021-22		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	4	11737	-	-	-	-
Private sector	-	-	-	-	-	-

beneficiation plant at Phondaghat in Sindhudurg district. The plant uses advanced technology in washing both by water and chemicals and further grading it in required fractions.

HEALTH HAZARDS

Respirable silica is still a cause of major concern to miners and consumers since many minerals, especially industrial sand and gravel contain crystalline silica. There is a potential threat to workers of getting subjected to "silicosis" in quartz, silica sand and gravel mines. Occupational safety measures & regulations to monitor the levels of crystalline silica in these mines are mandatory. In the USA, the Occupational Safety and Health Administration (OSHA) listed "crystalline silica" as one of their top five priorities for formulation of necessary rules. The OSHA, on the basis of significant information put out by International Agency for Research on Evaluation of Cancer has declared that any material containing more than 0.1% crystalline silica should indicate its carcinogenic hazard.

USES & SPECIFICATIONS

Quartz, quartzite and silica sand are used in various industries like glass, refractory, foundry, ceramic, cosmetic, electrical, abrasives, paints, etc. The primary use of silica is in the manufacture of virtually all types of glasswares, ceramics and ceramic glazes. Other major uses are in metallurgy, (where silica is used as a refractory, foundry mould, fluxes and as a source of silicon for the production of silicon metal and ferro-silicon and other ferro-alloys), silicon carbide manufacture, chemical & construction sectors and as a natural abrasive. Known for its piezoelectric properties, high quality quartz crystal is used in electronic devices, multiple

telephone lines, depth-sounding devices, range finders, chronometers, etc.

Sand is also used as a fireproofing material, for sandstowing in mines, soundproofing material and as a filler. Silica sand is also used to maintain or increase the permeability of oil and gas-bearing formations; its application as a filler in acid proof cements, putty, paints, epoxy & polyester resins is inevitable. Besides, it is widely used in horticulture as a filtration medium, and for ornamental purposes as well. Silica flour is used as a filler in plastic and rubber products.

Flint and chert are used in abrasives and tube-mill lining. Besides, chert is used in crushed form as aggregate for concrete and road surfacing. Rounded pebbles of chalcedony are used as balls in ball mill for finer crushing and grinding felspar, calcite & barytes. The different cryptocrystalline varieties of transparent and translucent chalcedony are valued as semi-precious stones and are carved out into a variety of ornaments and used for making different ornamental wares or articles of decoration. Agate pieces after cutting and polishing are sold as semi-precious stones. Big pieces are used in making mortars and pestles for laboratory use. Agate cut into requisite shapes is also used as fulcra of scientific balances and in making edges, planes and bearings of precision instruments.

In India, quartz, quartzite and silica sand are used mainly in glass, foundry, ferroalloys and refractory industries and also as building materials. According to its suitability for different purposes, it may be named as building sand, paving sand, moulding or foundry sand, refractory sand or furnace sand, filter sand, glass sand and grinding & polishing sand.

SUBSTITUTION

In order to reduce the potential threat of "silicosis", a variety of materials are used as substitutes for silica. Basic and neutral refractories (including magnesite, mag-chrome, dolomite and high alumina bricks) have replaced silica in a large number of applications. Chromite, olivine and zircon are alternatives to foundry sands. Garnet and to a lesser extent, olivine, are used in sand blasting to avoid the risk of silicosis. Wollastonite is more favoured than free silicon for use in the Ceramic Industry, again due to the risk of silicosis. In Electronic Industry, replacement of natural quartz crystal by cultured quartz crystal is increasing steadily. It has been estimated that about 10 billion quartz crystals and oscillators per year are manufactured and installed worldwide in all types of electronic devices.

FUTURE OUTLOOK

According to its suitability for different purposes, quartz & silica minerals are named as building sand, paving sand, moulding or foundry sand, refractory sand or furnace sand, glass sand,

etc. The future market demand of quartz and silica minerals will depend on its application. However, the main use of silica minerals is in the manufacture of different types of glasses, natural silica sand being the preferred material in the Glass Industry. In India, quartz, quartzite and silica sand are used mainly in glass, foundry, ferroalloys, refractory industries and also as building materials. Silica sand is used in the Oil Industry for the hydraulic fracturing process as it helps in the extraction of gases. The market demand of silica minerals may get very high due to increased use in horizontal well drilling by oil companies.

The demand for quartz, silica sand, moulding sand and quartzite is increasing over the years to cater to the requirement of ferrosilicon, silico-manganese, silico-chrome, silica refractories, glass and for moulding & casting purposes. The requirements of these products are linked up directly with Iron & Steel Industry including alloy steel production. Further, setting up foundries and enhancing their capacities are also linked with Metallurgical Industry. There are very good prospects of increasing the production and also the export of quartz and silica minerals to the neighbouring countries.