

5.1 COBALT

Introduction

Cobalt is a scarce and an important strategic alloying metal. It has strategic importance due to its ability to impart hardness and corrosion resistance to alloys at high temperature. It is used in super alloys for the industrial and aircraft engines. There is no production of cobalt in the country and demand is met through imports. Cobalt is found associated with copper, nickel and arsenic ore. Cobalt in association with nickeliferous limonite reported in Sukinda Valley, Odisha can be the potential source in India.

Basis of Grade Classification

Cobalt ore is not directly used in the industry, therefore the end-use grade classification is not attempted and entire estimation in the inventory as on 01.04.2020 has been placed in terms of its ore.

Basis of Categorisation of Resources

As per United Nations Framework Classification (UNFC), the resources are broadly classified into 'reserves and 'remaining resources'.

According to the norms of this system, estimation of cobalt ore has been made under 'remaining resources' and are placed under measured (331), indicated (332), inferred (333) and reconnaissance (334) categories.

Salient Features of the Inventory

The entire resources estimations as on 01.04.2020 of Cobalt ore in the country are placed

at about 44.91 million tonnes under 'remaining resources' category.

All India scenario of cobalt ore reserves, remaining resources and total resources as on 01.04.2020 vis-a-vis 01.04.2015 have been given in Tables-1 and 2. The tables give an idea about the significant changes in terms of increase or decrease of resources as per lease status, grades and states. In Table-3, district wise reserves/resources as on 01.04.2020 have been given.

There is no change in resource position of cobalt ore as compared to the previous inventory as on 01.04.2015. The resources were reported in three states namely Jharkhand, Nagaland and Odisha. Out of the total resources, about 69% have been estimated in Jajpur district, Odisha and the balance share of 31% resources have been accounted for by Singhbhum (East) district(20%), Jharkhand and Kiphire district(11%), Nagaland. The entire resources of Jharkhand and Nagaland are in freehold areas while almost entire resources of Odisha is under leasehold.

A total of eight deposits have been covered in National Mineral Inventory as on 01.04.2020, of which, five deposits are in freehold areas, two deposits in leasehold public and one deposit in leasehold private. Out of the five freehold deposits one deposit each from Karnataka, (Shimoga) and Nagaland (Tuensang) have reported occurrence of Cobalt ore, however estimation of quantity is not available.

**Table - 1 : Reserves/Resources of Cobalt Ore as on 01.04.2020 vis-à-vis 01.04.2015
(By Lease Status)**

Lease status	(In Million Tonnes)					
	Reserves			Total resources		
	01.04.2020	01.04.2015	Net change	01.04.2020	01.04.2015	Net change
All India : Total	-	-	No Change	44.91	44.91	No Change
Freehold	-	-	No Change	14.01	14.01	No Change
Leasehold (Private)	-	-	No Change	21.06	21.06	No Change
Leasehold (Public)	-	-	No Change	9.84	9.84	No Change

figures rounded off

**Table – 2 : Total Resources of Cobalt Ore as on 01.04.2020 vis-à-vis 01.04.2015
(By States)**

(In Million Tonnes)

State	Total Resources		Net Change
	As on 01.04.2020	As on 01.04.2015	
All India : Total	44.91	44.91	No Change
Jharkhand	9	9	No Change
Nagaland	5	5	No Change
Odisha	30.91	30.91	No Change

*figures rounded off***Table - 3 : District wise Reserves/Resources of Cobalt Ore as on 01.04.2020**

(In Million Tonnes)

State	District	Reserves	Remaining Resources	Total Resources
All India : Total		-	44.91	44.91
Jharkhand		-	9	9
	Singhbhum (East)	-	9	9
Nagaland		-	5	5
	Kiphire	-	5	5
Odisha		-	30.91	30.91
	Jajpur	-	30.91	30.91

figures rounded off

5.2 MOLYBDENUM

Introduction

Molybdenum does not occur in nature in free state. Usually, it is found in chemically combined form with other elements. Molybdenite (MoS_2) is the principal mineral from which molybdenum is obtained.

Molybdenum is principally used as alloying agent in steel, cast iron and super alloys to enhance hardness, strength and wear & corrosion resistance. As a refractory metal, it is used in many electrical and electronic components, as a resistance element in electronic furnaces. There is increasing usage of molybdenum in defence industries.

Basis of Grade Classification

Mined out molybdenum ore is not used directly in the industry and therefore, end-use grade classification of this mineral is not possible.

In USA, the ore is marketed only in the form of MoS_2 concentrate which is intermediate and end-product obtained from the ore. There is no BIS classification. Therefore, the grade classification for molybdenum in the inventory has been done as 'ore' and contained MoS_2 .

Basis of Resource Classification

As per United Nations Framework Classification (UNFC), resources are broadly classified into 'reserves' and 'remaining resources'.

According to the norms of this system, molybdenum ore and corresponding contained MoS_2 is placed under remaining resources in pre-feasibility (221), measured (331), indicated (332), inferred (333) and reconnaissance (334) categories.

Salient Features of the Inventory

The total resources as on 01.04.2020 of molybdenum ore in the country are estimated at 27,203

thousand tonnes with about 16.89 thousand tonnes of contained MoS_2 . The entire estimations fall under remaining resources category.

All India scenario of molybdenum ore and their contained MoS_2 under remaining resources and total resources as on 01.04.2020 vis-a-vis 01.04.2015 has been given in Tables 1 and 2. The tables give an idea about changes in terms of increase or decrease of resources as per lease status, grades and state. In Table - 3 district wise reserves/resources as on 01.04.2020 have been given.

Molybdenum resources are mainly distributed in Tamil Nadu with 17,882 thousand tonnes (65.73%) of ore containing 10.15 thousand tonnes of MoS_2 , Madhya Pradesh with 8,000 thousand tonnes (29.41%) of ore containing 5 thousand tonnes MoS_2 and Karnataka with 1,321 thousand tonnes (4.86%) of ore containing 1.72 thousand tonnes MoS_2 .

There is an overall increase of 7,831,700 tonnes of ore containing about 4,222.19 tonnes of MoS_2 reported in NMI as on 01.04.2020 as compared to previous inventory. It is solely due to addition of 4 new freehold deposits reported in Dharampuri district, Tamil Nadu.

About 74% (20,052 thousand tonnes) of the total resources of molybdenum containing 12.51 thousand tonnes of MoS_2 estimated in the country are under inferred (333) and reconnaissance (334) categories. These estimates are based on a very limited preliminary exploration. If these areas are examined for further detailed exploration, the confidence level of the molybdenum resources may improve.

Total 12 deposits of molybdenum have been covered in NMI as on 01.04.2020, of which 11 deposits are in freehold and one deposit in leasehold area.

Table - 1 : Reserves/Resources of Molybdenum as on 01.04.2020 vis-à-vis 01.04.2015
(By Lease Status/Grade)

Lease status/Grade	Reserves		Remaining resources		Total resources		(In Tonne)	
	01.04.2020	01.04.2015	01.04.2020	01.04.2015	01.04.2020	01.04.2015		
	Net change		Net change		Net change			
All India : Total	-	-	27,203,398	19,371,698	(+) 7,831,700	27,203,398	19,371,698	(+) 7,831,700
Ore	-	-	16,890.56	12,668.37	(+)4,222.19	16,890.56	12,668.37	(+)4,222.19
Freehold	-	-	1,92,03,398	11,371,698	(+) 78,31,700	1,92,03,398	11,371,698	(+) 78,31,700
Contained MoS₂	-	-	11,870.56	7,648.37	(+)4,222.19	11,870.56	7,648.37	(+)4,222.19
Leasehold (Public)	-	-	8,000,000	8,000,000	No Change	8,000,000	8,000,000	No Change
Ore	-	-	5,020	5,020	No Change	5,020	5,020	No Change
Contained MoS₂	-	-	-	-	No Change	-	-	No Change

85 *figures rounded off.*

**Table – 2 : Total Resources of Molybdenum as on 01.04.2020 vis-à-vis 01.04.2015
(By States)**

State	Total Resources		(In Tonne)
			Net Change
	As on 01.04.2020	As on 01.04.2015	
All India : Total			
Ore	27,203,398	19,371,698	(+) 7,831,700
Contained MoS₂	16,890.56	12,668.37	(+)4,222.19
Karnataka			
Ore	1,320,900	1,320,900	No Change
Contained MoS ₂	1,718.7	1,718.7	No Change
Madhya Pradesh			
Ore	8,000,000	8,000,000	No Change
Contained MoS ₂	5,020	5,020	No Change
Tamil Nadu			
Ore	17,882,498	10,050,798	(+)7,831,700
Contained MoS ₂	10,151.86	5,929.67	(+)4,222.19

*figures rounded off.***Table - 3 : District wise Reserves/Resources of Molybdenum as on 01.04.2020**

State	District	Reserves	(In Tonne)	
			Remaining Resources	Total Resources
All India : Total				
Ore		-	27,203,398	27,203,398
Contained MoS₂		-	16,890.56	16,890.56
Karnataka				
Ore		-	1,320,900	1,320,900
Contained MoS₂		-	1,718.7	1,718.7
	Kolar			
	Ore	-	1,320,000	1,320,000
	Contained MoS₂	-	1,716	1,716
	Raichur			
	Ore	-	900	900
	Contained MoS₂	-	2.7	2.7
Madhya Pradesh				
Ore		-	8,000,000	8,000,000
Contained MoS₂		-	5,020	5,020
	Balaghat			
	Ore	-	8,000,000	8,000,000
	Contained MoS₂	-	5,020	5,020
Tamil Nadu				
Ore		-	17,882,498	17,882,498
Contained MoS₂		-	10,151.86	10,151.86
	Dharampuri			
	Ore	-	16,558,320	16,558,320
	Contained MoS₂	-	9,620.06	9,620.06
	Dindigul			
	Ore	-	519,000	519,000
	Contained MoS₂	-	352	352
	Krishnagiri			
	Ore	-	84,966	84,966
	Contained MoS₂	-	28.8	28.8
	Vellore			
	Ore	-	720,212	720,212
	Contained MoS₂	-	151	151

figures rounded off.

5.3 NICKEL ORE

Introduction

Nickel is a silver white metal used as an alloy both in ferrous and non-ferrous applications, mainly in steel alloy. Besides, nickel is also used in nickel plating, coin making, ceramics, colouring glass, batteries, electronic circuits and nickel compounds. Nickel is a strategic metal and is found associated with the lateritic deposits of Sukinda valley in Odisha. Nickel is not produced from primary sources in the country and the entire demand is met through imports. However, it is recovered as a by-product in the form of nickel sulphate during refining of copper at Ghatsila copper smelter of Hindustan Copper Ltd. (HCL) in Jharkhand.

Another important source is nickeliferous limonite in the overburden of chromite in Sukinda valley, Jajpur district, Odisha. A suitable process is being developed for its utilisation. In addition, nickel is found associated with uranium deposits at Jaduguda, Jharkhand and a process is being developed for its recovery. Resources are spread over in Singhbhum East district of Jharkhand and Jajpur, Keonjhar, Mayurbhanj districts of Odisha. Resources of nickel ore are also reported from Nagaland and Karnataka and occurrences are reported from Kerala.

Basis of Grade Classification

In the inventory as on 01.04.2020 the resources of Nickel ore have been classified into the following grades:

- i) Ore with (+) 0.9% Ni
- ii) Ore with 0.5 to 0.9% Ni
- iii) Ore with (+) 0.5% Ni (Unclassified)
- iv) Not known grade.

Basis of Categorisation of Resources

As per United Nations Framework Classification (UNFC), total resources are broadly classified into 'reserves' and 'remaining resources' category.

According to the norm of this system, the estimation of nickel ore in the country have been placed under pre-feasibility (221) & (222), measured (331), indicated (332) and inferred (333) categories of remaining resources.

Salient Features of the Inventory

The total resources of nickel ore in the country as on 01.04.2020 are estimated at 188.86 million tonnes.

The entire resources fall under remaining resource category. There is no change in total resources of nickel ore as compared to previous inventory as on 01.04.2015.

All India scenario of nickel ore reserves, remaining resources and total resources as on 01.04.2020 vis-a-vis 01.04.2015 have been given in Tables - 1 and 2. The tables give an idea about the significant changes in terms of increase or decrease of resources as per lease status, grade and states. In Table-3, district-wise reserves/ resources as on 01.04.2020 have been given.

Out of the total resources of 188.86 million tonnes of nickel ore, about 90.66 million tonnes (48%) have been placed in freehold, 58.23 million tonnes (31%) in leasehold private and 39.97 million tonnes (21%) in leasehold public areas.

Of the total resources, ore containing 0.5 to 0.9% Ni are 93.53 million tonnes (50%), followed by ore containing (+)0.5% Ni (unclassified) are 52.97 million tonnes (28%) and resources of ore containing (+) 0.9% Ni are 42.13 million tonnes (22%). A meager quantity of 0.23 million tonnes nickel ore has been placed under not known grade .

The state of Odisha endowed with the largest share of resources of nickel ore in the country at 174.63 million tonnes (92%). These resources have mainly been distributed in three districts, namely Jajpur (139.66 million tonnes), Mayurbhanj (27 million tonnes) and Keonjhar (7.97 million tonnes). Jharkhand has 9 million tonnes (5%) resources estimated in Singhbhum (East) district. Nagaland has 5 million tonnes (3%) resources mainly in Kiphire district. A very meager quantity about 0.23 million tonnes has been estimated in North Kanara district, Karnataka .

The entire resources of nickel ore are placed under remaining resources. Out of this, 63.49 million tonnes (34%) are reported under inferred (333) category. These resources are based on a limited and preliminary exploration. A detailed exploration in these areas may improve the confidence level of the resources.

Total 10 deposits have been covered in the inventory as on 01.04.2020. Out of this, 6 deposits are in freehold and 2 deposits each in leasehold public and in leasehold private areas.

**Table - 1 : Reserves/Resources of Nickel as on 01.04.2020 vis-à-vis 01.04.2015
(By Lease Status/Grade)**

Lease status/Grade	Reserves		Remaining resources		Total resources	
	01.04.2020	01.04.2015	01.04.2020	01.04.2015	01.04.2020	01.04.2015
	Net change		Net change		Net change	
All India : Total	-	-	188.86	188.86	188.86	188.86
(+)0.9% Ni	-	-	42.13	42.13	42.13	No Change
0.5 to 0.9% Ni	-	-	93.53	93.53	93.53	No Change
(+) 0.5 % Ni Unclassified	-	-	52.97	52.97	52.97	No Change
Not known	-	-	0.23	0.23	0.23	No Change
Freehold	-	-	90.66	90.66	90.66	90.66
(+)0.9% Ni	-	-	33.75	33.75	33.75	No Change
0.5 to 0.9% Ni	-	-	56.91	56.91	56.91	No Change
Leasehold (Private)	-	-	58.23	58.23	58.23	58.23
0.5 to 0.9% Ni	-	-	21.06	21.06	21.06	No Change
(+) 0.5 % Ni Unclassified	-	-	36.94	36.94	36.94	No Change
Not Known	-	-	0.23	0.23	0.23	No Change
Leasehold (Public)	-	-	39.97	39.97	39.97	39.97
(+) 0.9% Ni	-	-	8.38	8.38	8.38	No Change
0.5 to 0.9% Ni	-	-	15.56	15.56	15.56	No Change
(+) 0.5 % Ni Unclassified	-	-	16.03	16.03	16.03	No Change

figures rounded off.

**Table – 2 : Total Resources of Nickel as on 01.04.2020 vis-à-vis 01.04.2015
(By States)**

(In Million Tonnes)

State	Total Resources		Net Change
	As on 01.04.2020	As on 01.04.2015	
All India : Total	188.86	188.86	No Change
Jharkhand	9.0	9.0	No Change
Karnataka	0.23	0.23	No Change
Nagaland	5.00	5.00	No Change
Odisha	174.63	174.63	No Change

*figures rounded off.***Table - 3 : District wise Reserves/Resources of Nickel as on 01.04.2020**

(In Million Tonnes)

State	District	Reserves	Remaining Resources	Total Resources
All India : Total		-	188.86	188.86
Jharkhand		-	9	9
	Singhbhum (East)	-	9	9
Karnataka		-	0.23	0.23
	North Kanara	-	0.23	0.23
Nagaland		-	5	5
	Kiphire	-	5	5
Odisha		-	174.63	174.63
	Jajpur	-	139.66	139.66
	Keonjhar	-	7.97	7.97
	Mayurbhanj	-	27	27

figures rounded off.

5.4 RARE EARTH ELEMENTS

Introduction

The rare earth group contains 17 elements as defined by International Union of Pure and Applied Chemistry (IUPAC) namely, scandium (Sc), yttrium (Y) and lanthanides (15 elements in the periodic table with atomic numbers from 57 to 71, namely, lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb) and lutetium (Lu). Although they tend to occur together, the 15 lanthanide Elements are divided into two groups - light & heavy elements. The light elements are those with atomic numbers from 57 to 63 (La, Ce, Pr, Nd, Pm, Sm and Eu) and the heavy elements are those with atomic numbers from 64 to 71 (Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu). Generally, the light rare earth elements are more common and more easily extracted than the heavies. In spite of its low atomic weight, yttrium has properties more similar to the heavy lanthanides and is included with this group. Scandium, besides occurring with other rare earth elements is also found in a number of minerals.

Rare Earth Elements (REE) are characterised by high density, high melting point, high conductivity and high thermal conductance. A number of rare earth minerals contain thorium and uranium in variable amounts but thorium and uranium do not constitute essential components in the composition of the minerals.

The principal sources of rare earth elements are bastnaesite (a fluorocarbonate which occurs in carbonatites and related igneous rocks), xenotime (yttrium phosphate) commonly found in mineral sand deposits, loparite which occurs in alkaline igneous rocks and monazite (a phosphate). The rare earths occur in many other minerals and are recoverable as by-products from phosphate rock and from spent uranium leaching. In India, monazite is the principal source of rare earths and thorium.

Basis of Grade Classification

The following grade classification has been adopted in the mineral inventory as on 01.04.2020.

Unclassified : Estimation for which supporting data is not available to classify under any grade.

Basis of Categorisation of Resources

As per United Nations Framework Classification (UNFC), total resources are broadly classified into 'reserves' and 'remaining resources' category.

According to norms of this system reserves / resources of Rare Earth Element has been placed under indicated (332), inferred (333) and reconnaissance (334) categories of resources.

Salient Features of the Inventory

All India scenario of REE reserves, remaining resources and total resources as on 01.04.2020 vis-a-vis 01.04.2015 have been appended in Table - 1 and 2. In Table 3, district-wise reserves/ resources as on 01.04.2020 have been given.

The total resources of Rare Earth Elements in the country as on 01.04.2020 are estimated at 459,727 tonnes and are placed in freehold category. As compared to inventory as on 01.04.2015, there is an increase of 434,234 tonnes of resources which is mostly due to a newly reported Ambadungar freehold deposit in Gujarat state where the entire resources of Gujarat state is estimated.

By states, Gujarat alone account for 92% of the total resources of the country followed by Odisha (5.54%), Karnataka (0.81%), Uttar Pradesh (0.64%), Maharashtra (0.45%) and remaining by the states of Bihar and Jharkhand.

About 29,374 tonnes (6%) of the total resources have been estimated under inferred and reconnaissance categories. These resources are based on a limited and preliminary exploration. If these areas are explored in detail the confidence level of resource position of graphite in the country may enhance.

In previous inventory 2015, entire resources of REE were reported from Odisha state only. However, during the present inventory ten new freehold deposits were reported from the states of Bihar (3), Gujarat (1), Jharkhand (1), Karnataka (2), Maharashtra (1) and Uttar Pradesh (2).

A total of 15 freehold deposits have been covered in the present inventory.

**Table - 1 : Reserves/Resources of Rare Earth Elements (REE) as on 01.04.2020 vis-à-vis 01.04.2015
(By Lease Status/Grade)**

	(In Tonne)					
	Reserves		Remaining resources		Total resources	
	01.04.2020	01.04.2015	01.04.2020	01.04.2015	01.04.2020	01.04.2015
		Net change		Net change		Net change
All India : Total	-	-	459,727	25,493	459,727	25,493
Unclassified	-	-	459,727	25,493	459,727	25,493
Free Hold	-	-	459,727	25,493	459,727	25,493
Unclassified	-	-	459,727	25,493	459,727	25,493

figures rounded off.

**Table – 2 : Total Resources of Rare Earth Elements as on 01.04.2020 vis-à-vis 01.04.2015
(By States)**

(In Tonne)

State	Total Resources		Net Change
	As on 01.04.2020	As on 01.04.2015	
All India : Total	459,727	25,493	(+)434,234
Bihar	1,459	-	(+)1,459
Gujarat	424,000	-	(+)424,000
Jharkhand	4	-	(+)4
Karnataka	3,734	-	(+)3,734
Maharashtra	2,090	-	(+)2,090
Odisha	25,493	25,493	No change
Uttar Pradesh	2,948	-	(+)2,948

Figures rounded off.

**Table – 3 : Districtwise Reserve / Resources of Rare Earth Elements as on 01.04.2020
(By States)**

(In Tonne)

State	District	Reserves	Remaining Resources	Total Resources
All India : Total		-	459,727	459,727
Bihar		-	1,459	1,459
	Banka	-	1,459	1,459
Gujarat		-	424,000	424,000
	Chota Udaipur	-	424,000	424,000
Jharkhand		-	4	4
	Godda	-	4	4
Karnataka		-	3,734	3,734
	Koppal	-	384	384
	Raichur	-	3,350	3,350
Maharashtra		-	2,090	2,090
	Nagpur	-	2,090	2,090
Odisha		-	25,493	25,493
	Ganjam	-	19,140	19,140
	Puri	-	6,353	6,353
Uttar Pradesh		-	2,948	2,948
	Sonbhadra	-	2,948	2,948

Figures rounded off.

5.5 TIN

Introduction

Tin is a silver white metal with bluish tint, malleable and ductile in nature. Tin is one of the earliest known metal in use for making bronze. The largest single use of tin is in tin plating of iron, steel, copper, etc. Other major use of tin is in alloys such as solder and bronze. In India tin ore is found associated with granite, pegmatites and quartz veins and also in placer deposits. Resources are spread over in Bastar and Dantewada districts of Chhattisgarh, Tosham deposit in Bhiwani district of Haryana and Malkangiri district of Odisha. The production of tin in the country is not substantial. Chhattisgarh was the only state producing tin concentrates.

Basis of Grade Classification

Before putting to any end-use, tin ore is converted into concentrate and then smelted for extraction of metal. Therefore the grades of tin have been classified under ore and metal.

Basis of Categorisation of Resources

As per United Nations Framework Classification (UNFC), total resources are broadly classified into 'reserves' and 'remaining resources' category.

According to the norm of this system, the reserves of tin ore and corresponding metal in the country have been placed under proved (111) and probable (122) categories. The remaining resources have been placed under feasibility (211), pre-feasibility (221) & (222), measured (331), indicated (332) and inferred (333) categories.

Salient Features of the Inventory

The total resources of tin ore in the country as on 01.04.2020 are estimated at about 83,723 thousand tonnes containing 103.76 thousand tonnes metal. Out of these, only 2.10 thousand tonnes ore reported under reserve category containing 973.99 tonnes metal and the balance 83,721 thousand tonnes ore are in remaining resource category containing 102.78 thousand tonnes metal.

All India scenario of tin ore and corresponding metal reserves, remaining resources and total resources as on 01.04.2015 vis-a-vis 01.04.2010 have been given in Tables - 1 and 2. The tables give an idea about the significant changes in terms of increase or decrease of resources as per lease status, grade and states. In Table-3, district-

wise reserves/resources as on 01.04.2020 have been given.

Almost entire tin ore resources estimated in the country comprising 83,718 thousand tonnes (99.99%) have been placed under freehold category. A meagre quantity of about 1.6 thousand tonnes of ore are placed under public leasehold and about 3.4 thousand tonnes under private leasehold category.

The state of Haryana is endowed with the largest share of total resources of tin ore in the country at 53,910 thousand tonnes (64%) containing 86.22 thousand tonnes metal in Bhiwani district. Chhattisgarh has 29,797 thousand tonnes (35.6%) tin ore resources containing 16.88 thousand tonnes metal, estimated in Bastar district (29,792 thousand tonnes tin ore, containing 14.26 thousand tonnes metal) and Dantewara district (4.96 thousand tonnes tin ore containing 2.62 thousand tonnes metal). Odisha has the remaining resources of 16 thousand tonnes tin ore containing 0.65 thousand tonnes metal estimated in Malkangiri district.

Total three new leasehold (private) deposits i.e. two deposits in Chattisgarh and one in Odisha, with total resources of 321 tonnes of ore containing 247 tonnes of metal has been reported in NMI 2020.

An overall net decrease of 2.27 thousand tonnes of tin ore resources has been recorded in NMI 2020 as compared to the resources as on 01.04.2015. The entire decrease in the ore resources are reported from Dantewada district of Chhattisgarh due to downward revision of resources reported in leasehold (private) deposits. Metal content, however, is increase by 1343.54 tonnes due to addition of three new leasehold private deposits and upward revision of metal resources in existing Bade Bacheli deposits and also minor increase in Odisha state due to addition of a new deposit.

A sizeable quantity of the total resources of tin ore, about 29,063 thousand tonnes (35%) has been estimated under inferred category. These resources are based on a limited and preliminary exploration. A detailed exploration in these areas may improve the confidence level of the resources.

A total 29 deposits have been covered in the inventory as on 01.04.2020. Out of these 13 deposits are in freehold and remaining 16 deposits are in leasehold areas (10 leasehold private and 6 leasehold public).

**Table - 1 : Reserves/Resources of Tin as on 01.04.2020 vis-à-vis 01.04.2015
(By Lease Status/Grade)**

Lease status/Grade	Reserves			Remaining resources			Total resources		
	01.04.2020	01.04.2015	Net change	01.04.2020	01.04.2015	Net change	01.04.2020	01.04.2015	Net change
	(In Tonne)								
All India : Total									
Ore	2,101	4,419	(-)2,318	83,720,794	83,720,749	(+)45	83,722,895	83,725,168	(-)2,273
Metal	973.99	154.2	(+)819.79	102,782.91	102,259.16	(+)523.75	103,756.9	102,413.36	(+)1,343.54
Freehold									
Ore	-	-	-	83,717,814	83,717,814	No Change	83,717,814	83,717,814	No Change
Metal	-	-	-	101,048.04	101,048.04	No Change	101,048.04	101,048.04	No Change
Leasehold (Private)									
Ore	2,101	4,419	(-)2,318	1,342	1,216	(+)126	3,443	5,635	(-)2,192
Metal	973.99	154.2	(+)819.79	640.41	68.13	(+)572.28	1,614.40	222.33	(+)1,392.07
Leasehold (Public)									
Ore	-	-	-	1,638	1,719	(-)81	1,638	1,719	(-)81
Metal	-	-	-	1,094.46	1,142.99	(-)48.53	1,094.46	1,142.99	(-)48.53

figures rounded off.

**Table – 2 : Total Resources of Tin as on 01.04.2020 vis-à-vis 01.04.2015
(By States)**

State	Total Resources		Net Change
	(In Tonne)		
	As on 01.04.2020	As on 01.04.2015	
All India : Total			
Ore	83,722,895	83,725,168	(-)2,273
Metal	103,756.9	102,413.36	(+)1,343.54
Chhattisgarh			
Ore	29,797,277	29,799,674	(-)2,397
Metal	16,883.57	15,625.15	(+)1,258.42
Haryana			
Ore	53,910,000	53,910,000	No Change
Metal	86,220.6	86,220.6	No Change
Odisha			
Ore	15,618	15,494	(+)124
Metal	652.73	567.61	(+)85.12

figures rounded off.

Table - 3 : District wise Reserves/Resources of Tin as on 01.04.2020

State	District	Reserves	Remaining Resources	(In Tonne)
				Total Resources
All India : Total				
Ore		2,101	83,720,794	83,722,895
Metal		973.99	102,782.91	103,756.90
Chhattisgarh				
Ore		2,101	29,795,176	29,797,277
Metal		973.99	15,909.58	16,883.57
	Bastar			
	Ore	-	29,792,320	29,792,320
	Metal	-	14,259.83	14,259.83
	Dantewada			
	Ore	2,101	2,856	4,957
	Metal	973.99	1,649.75	2,623.74
Haryana				
Ore		-	53,910,000	53,910,000
Metal		-	86,220.6	86,220.6
	Bhiwani			
	Ore	-	53,910,000	53,910,000
	Metal	-	86,220.6	86,220.6
Odisha				
Ore		-	15,618	15,618
Metal		-	652.73	652.73
	Malkangiri			
	Ore	-	15,618	15,618
	Metal	-	652.73	652.73

figures rounded off.

5.6 TITANIUM MINERALS

Introduction

Titanium minerals, particularly ilmenite and rutile are grouped as 'prescribed substances' as per gazette notifications issued under the Atomic Energy Act, 1962. These mineral deposits are often referred to as heavy mineral deposits.

Ilmenite (FeOTiO_2) and Rutile (TiO_2) are the two chief minerals of Titanium. Anatase is one of the polymorphic forms in which titanium dioxide occurs. Leucoxene is an alteration product associated with ilmenite. Titaniferous magnetite is also the source of Titanium.

These minerals occur mainly along coastal stretches of the country and also in inland placers.

Ilmenite is mainly used for the manufacture of titanium dioxide, a white pigment for paints and also for manufacturing synthetic rutile. Rutile is used for coating welding electrodes and in the production of titanium metal sponge.

Basis of Grade Classification

Chemical analysis of the constituents of ilmenite and rutile is usually not carried out at the time of reporting of the resources. Hence, the resources are not classified according to the end-use grades but as their constituent mineral viz., ilmenite, rutile, leucoxene, anatase and titaniferous magnetite.

Basis of Categorization of Resources

As per the United Nations Framework Classification (UNFC), the total resources are broadly classified into 'reserves' and 'remaining resources' category.

According to the norms of this system, the reserves of titanium minerals have been placed under proved (111) and probable (121) & (122) categories.

The remaining resources have been placed under feasibility (211), pre-feasibility (221) & (222), measured (331), indicated (332), inferred (333) and reconnaissance (334) categories.

Salient Features of the Inventory

The total resources of Titanium minerals in the country as on 01.04.2020 have been estimated at about

427 million tonnes. Out of these, about 16 million tonnes (4%) have been placed under 'reserves' category and the balance 411 million tonnes (96%) under 'remaining resources' category. About 92% resources are estimated in freehold whereas 8% are estimated in leasehold public and private areas.

All India scenario of titanium minerals reserves, remaining resources and total resources as on 01.04.2020 vis-a-vis 01.04.2015 have been given in Tables - 1 and 2. The tables give an idea about the significant changes in terms of increase or decrease of resources as per lease status, grade, and states. In Table- 3, district wise reserves/resources as on 01.04.2020 have been given.

Out of the total resources, about 363 million tonnes (85.01%) are ilmenite, 19.6 million tonnes (4.58%) rutile, 0.61 million tonnes (0.14%) leucoxene, 3.3 million tonnes (0.78%) Anatase and 40.48 million tonnes (9.48%) resources are comprised of titaniferous magnetite.

The resources of titanium mineral are mainly reported in Kerala (28%), Tamil Nadu (27%), Andhra Pradesh (18%) and Odisha (15%). The balance 12% resources have been reported from Karnataka, Jharkhand, Maharashtra, Meghalaya and West Bengal.

In the inventory as on 01.04.2020, the resources of titanium minerals registered an overall increase of about 13 million tonnes as compared to the earlier inventory as on 01.04.2015. A total 4 new deposits with 23 million tonnes resources were reported in the inventory as on 01.04.2020. An increase of about 22 million tonnes has been recorded in Jharkhand state mainly due to inclusion of 3 new freehold deposits in district of Gumla and Latehar of Jharkhand. In Odisha also an increase of 0.19 million tonnes of resources recorded due to re-estimation of resources in leasehold deposit i.e. OSCOM. However, resources has been decreased in the states of Tamil Nadu, Kerala and Maharashtra by about 9 million tonnes due to production and downward revision of the same.

Of the total resources of titanium minerals, a substantial quantity of about 347.81 million tonnes (81.43%) are estimated under inferred and reconnaissance categories. The detailed exploration of these resources may improve confidence level of resource estimation in the country.

Table - 1 : Reserves/Resources of Titanium Minerals as on 01.04.2020 vis-à-vis 01.04.2015
(By Lease Status/Grade)

Lease status/Grade	Reserves			Remaining resources			Total resources		
	01.04.2020	01.04.2015	Net change	01.04.2020	01.04.2015	Net change	01.04.2020	01.04.2015	Net change
	(In Tonne)	(In Tonne)	(In Tonne)	(In Tonne)	(In Tonne)	(In Tonne)	(In Tonne)	(In Tonne)	(In Tonne)
All India : Total	15,998,625	14,420,716	(+1,577,909)	411,108,526	399,204,829	(+11,903,697)	427,107,150	413,625,545	(+13,481,605)
Ilmenite	14,960,819	13,813,510	(+1,147,309)	348,116,147	340,702,590	(+7,413,557)	363,076,966	354,516,100	(+8,560,866)
Rutile	701,010	594,291	(+106,719)	18,866,399	13,536,871	(+5,329,528)	19,567,408	14,131,162	(+5,436,246)
Leucoxene	33,245	-	(+33,245)	574,949	968,846	(-393,897)	608,194	968,846	(-360,652)
Anatase	-	-	-	3,345,000	3,345,000	No Change	3,345,000	3,345,000	No Change
Titaniferous Magnetite	303,551	-	(+303,551)	40,174,666	40,620,157	(-445,491)	40,478,217	40,620,157	(-141,940)
Not Known	-	12,915	(-12,915)	31,365	31,365	No Change	31,365	44,280	(-12,915)
Freehold	-	-	-	391,381,411	369,162,644	(+22,218,767)	391,381,411	369,162,644	(+22,218,767)
Ilmenite	-	-	-	330,199,147	313,799,147	(+16,400,000)	330,199,147	313,799,147	(+16,400,000)
Rutile	-	-	-	17,684,776	11,866,009	(+5,818,767)	17,684,776	11,866,009	(+5,818,767)
Leucoxene	-	-	-	1,994	1,994	No Change	1,994	1,994	No Change
Anatase	-	-	-	3,345,000	3,345,000	No Change	3,345,000	3,345,000	No Change
Titaniferous Magnetite	-	-	-	40,150,494	40,150,494	No Change	40,150,494	40,150,494	No Change
Leasehold (Private)	-	-	-	31,365	31,365	No Change	31,365	31,365	No Change
Not Known	-	-	-	31,365	31,365	No Change	31,365	31,365	No Change
Leasehold (Public)	15,998,625	14,420,716	(+1,577,909)	19,695,750	30,010,820	(-10,315,070)	35,694,374	44,431,536	(-8,737,162)
Ilmenite	14,960,819	13,813,510	(+1,147,309)	17,917,000	26,903,443	(-8,986,443)	32,877,819	40,716,953	(-7,839,134)
Rutile	701,010	594,291	(+106,719)	1,181,623	1,670,863	(-489,240)	1,882,632	2,265,154	(-382,521)
Leucoxene	33,245	-	(+33,245)	572,955	966,852	(-393,897)	606,200	966,852	(-360,652)
Titaniferous Magnetite	303,551	-	(+303,551)	24,172	469,663	(-445,491)	327,723	469,663	(-141,940)
Not Known	-	12,915	(-12,915)	-	-	-	-	12,915	(-12,915)

figures rounded off.

National Mineral Inventory - An Overview

A comparative analysis of grade wise resources reveals an overall increase in the resources of ilmenite and rutile while the resources of leucosene, not known and Titaniferous magnetite shows a slight decrease. There is no change in resources of Anatase.

A total of 114 deposits of titanium minerals have been covered in National Mineral Inventory as on 01.04.2020. Out of these, 103 deposits are in freehold and 10 deposits are in leasehold public and one deposit in leasehold private areas.

Table – 2 : Total Resources of Titanium Minerals as on 01.04.2020 vis-à-vis 01.04.2015 (By States)

State	Total Resources		Net Change
	(In Tonne)		
	As on 01.04.2020	As on 01.04.2015	
All India : Total	427,107,150	413,625,545	(+)13,481,605
Andhra Pradesh	76,733,874	76,733,874	No Change
Jharkhand	26,603,767	4,385,000	(+)22,218,767
Karnataka	13,862,094	13,862,094	No Change
Kerala	119,978,371	128,712,668	(-)8,734,297
Maharashtra	4,284,337	4,426,277	(-)141,940
Meghalaya	3,345,000	3,345,000	No Change
Odisha	65,673,202	65,478,984	(+)194,218
Tamil Nadu	114,347,505	114,402,648	(-)55,143
West Bengal	2,279,000	2,279,000	No Change

figures rounded off.

Table - 3 : District wise Reserves/Resources of Titanium Minerals as on 01.04.2020

State	District	Reserves		
		Reserves	Remaining Resources	Total Resources
All India : Total		15,998,625	411,108,526	427,107,150
Andhra Pradesh		-	76,733,874	76,733,874
	Godavari (East)	-	34,000,000	34,000,000
	Krishna	-	4,950,000	4,950,000
	Nellore	-	330,000	330,000
	Srikakulam	-	21,782,509	21,782,509
	Visakhapatnam	-	15,671,365	15,671,365
Jharkhand		-	26,603,767	26,603,767
	Gumla	-	18,738,767	18,738,767
	Latehar	-	3,480,000	3,480,000
	Ranchi	-	755,000	755,000
	Singhbhum (East)	-	3,630,000	3,630,000
Karnataka		-	13,862,094	13,862,094
	Hassan	-	742,430	742,430
	North Kanara	-	5,292,664	5,292,664
	Shimoga	-	7,827,000	7,827,000

(contd.)

National Mineral Inventory - An Overview

Table-3 (Concl.)

State	District	Reserves	Remaining Resources	Total Resources
Kerala		2,370,712	117,607,659	119,978,371
	Alapuzha (Alleppy)	-	537,191	537,191
	Kasargod	-	114,550	114,550
	Kollam	2,370,712	108,497,338	110,868,050
	Pathanamthitta	-	8,154,330	8,154,330
	Thiruvananthapuram	-	304,250	304,250
Maharashtra		303,551	3,980,786	4,284,337
	Gondia	303,551	1,452,572	1,756,123
	Ratnagiri	-	2,528,214	2,528,214
Meghalaya		-	3,345,000	3,345,000
	Khasi Hills East	-	3,345,000	3,345,000
Odisha		12,654,141	53,019,062	65,673,202
	Dhenkanal	-	2,700,000	2,700,000
	Ganjam	12,654,141	12,409,798	25,063,938
	Jajpur	-	4,150,000	4,150,000
	Mayurbhanj	-	21,230,000	21,230,000
	Puri	-	12,529,264	12,529,264
Tamil Nadu		670,221	113,677,284	114,347,505
	Kanyakumari	670,221	7,680,085	8,350,306
	Nagapattinam	-	1,114,880	1,114,880
	Ramnathapuram	-	6,680,320	6,680,320
	Thiruvallur	-	68,920	68,920
	Tirunelveli	-	22,267,231	22,267,231
	Tuticorin	-	75,865,848	75,865,848
West Bengal		-	2,279,000	2,279,000
	Purulia	-	2,279,000	2,279,000

figures rounded off.

5.7 TUNGSTEN

Introduction

Tungsten is a metal of strategic importance in times of war and is essential for the industrial development of the country. Tungsten is heavy (Sp. Gr.19.3) and highly refractory metal (melting point 3422^o C). It has good corrosion resistance, good thermal and electrical conductivity and low co-efficient of expansion. At temperature above 1650^oC, it has the highest tensile strength of all metals. The major sources of tungsten are minerals scheelite (CaWO₄) and Wolframite [(Fe,Mn)WO₄].It is a hard steel-gray shiny metal.

Tungsten is mainly used in the manufacture of ferro-tungsten and in certain non-ferrous alloys. These alloys are used for high speed tools, cutting tools, etc. Tungsten is also used in making filament in electrical lamps.

Tungsten occurs either as scheelite or wolframite in granite/pegmatite and quartz veins. The only experience of producing tungsten ore in the country is from Degana area of Nagaur district, Rajasthan and Chendapathar in West Bengal. The area was mined first by RSMDC and then by HZL till recent past. Presently, there is no production of tungsten ore in the country due to economic non-viability.

Basis of Grade Classification

The tungsten ore is converted into WO₃ concentrate and then marketed for manufacture of various products. Therefore the reserves/resources have broadly been classified into ore and contained WO₃.

The concentrate specifications for commercial purpose are determined in terms of WO₃ content. Any concentrate with 65% or more WO₃ content is considered saleable material. However low grade concentrate can also be used to make intermediate product provided the product can be obtained at an economic cost.

In Degana area of Rajasthan & Chendapathar, West Bengal, the minimum economic grade of tungsten ore considered was 0.1% WO₃ content for production of saleable concentrate. Incidence of WO₃ in the tungsten ore in the different areas of the country is as under :

At Degana, Rajasthan, out of 7 blocks minimum and maximum value of WO₃ was noticed 0.09% & 1.62%, respectively. At Balda of Sirohi district, Rajasthan, average WO₃ content ranges from 0.24 to 0.48 per cent. In Dewa-Ka-Bera of Sirohi district the average WO₃ is 0.03% and in Udwarya of Sirohi that is 0.27%. In West Bengal, Bankura deposit contains on an average, 0.1% WO₃. In Kuhi-Khobana-Agargaon belt of Maharashtra, GSI has estimated resources in Sakoli basin in Bhandara and Nagpur district, Maharashtra. The analysis showed 0.01 to 0.19% WO₃ in Kuhi block, 0.13 to 0.38% WO₃ in Khobana block and 0.48% WO₃ in Pardi-Dahegaon-Pipalgaon block. Gold ore at Mysore mine of BGML in Karnataka has been reckoned as a potential source of scheelite. The tailing dumps at Kolar Gold Fields(as per NMI sheet available) contain about 0.01 to 0.05% WO₃.

Basis of Categorisation of Resources

As per United Nations Framework Classification (UNFC), total resources are broadly classified into 'reserves' and 'remaining resources' category.

According to the norms of this system, resources of tungsten ore and corresponding contained WO₃ have been placed under feasibility (211), pre-feasibility (222), measured (331), indicated (332), inferred (333) and reconnaissance (334) of remaining resources category.

Salient Features of the Inventory

The total resources of tungsten ore in the country as on 01.04.2020 are estimated at 89.43 million tonnes containing 144.65 thousand tonnes WO₃. The entire estimated quantity has been placed under remaining resources category in freehold areas. All India resources of tungsten ore has been increased by 2.05 million tonnes and corresponding contained WO₃ by 2.56 thousand tonnes due to addition of one new freehold deposit in Maharashtra state.

All India scenarios of tungsten reserves, remaining resources and total resources as on 01.04.2020 vis-a-vis 01.04.2015 is given in Tables-1 and 2. The tables give an idea about the

**Table - 1 : Reserves/Resources of Tungsten as on 01.04.2020 vis-à-vis 01.04.2015
(By Lease Status/Grade)**

Lease status/Grade	Reserves		Remaining resources		Total resources		Net change	Net change	Net change
	01.04.2020	01.04.2015	01.04.2020	01.04.2015	01.04.2020	01.04.2015			
All India : Total	-	-	89,432,464	87,387,464	(+)2,045,000	89,432,464	87,387,464	(+)2,045,000	
Ore	-	-	89,432,464	87,387,464	(+)2,045,000	89,432,464	87,387,464	(+)2,045,000	
Contained WO₃	-	-	144,650.07	142,094.35	(+)2,555.72	144,650.07	142,094.35	(+)2,555.72	
Freehold									
Ore	-	-	89,432,464	87,387,464	(+)2,045,000	89,432,464	87,387,464	(+)2,045,000	
Contained WO₃	-	-	144,650.07	142,094.35	(+)2,555.72	144,650.07	142,094.35	(+)2,555.72	

figures rounded off.

significant changes, if any, in terms of increase or decrease of resources as per lease status, grade and states. In Table-3, district-wise reserves/resources as on 01.04.2020 have been given.

Of the total resources, Karnataka is leading with 36.68 million tonnes ore (41.01%) containing 6.2 thousand tonnes of WO₃ followed by Rajasthan 23.93 million tonnes ore (26.75%) containing 93.7 thousand tonnes of WO₃. Andhra Pradesh 14.80 million tonnes ore (16.55%) containing 20.26 thousand tonnes of WO₃. The Remaining about 16% resources are estimated in Maharashtra, Haryana, Uttarakhand, Tamil Nadu and West Bengal.

Maharashtra, recorded a increase of 2,045 thousand tonnes ore with contained WO₃ 2.56 thousand tonnes due to addition of one new freehold deposit i.e, Kuhi-Khobna-Agargaon in Nagpur District.

Of the total resources of tungsten, about 40 million tonnes (45%) have been estimated under inferred (333) & reconnaissance (334) categories. These resources are based on limited & preliminary exploration. If these resources are explored further, the confidence level of resource estimation may improve.

A total 22 deposits (freehold) have been covered in National Mineral inventory as on 01.04.2020.

**Table – 2 : Total Resources of Tungsten as on 01.04.2020 vis-à-vis 01.04.2015
(By States)**

State	Total Resources		Net Change
	(In Tonne)		
	As on 01.04.2020	As on 01.04.2015	
All India : Total			
Ore	89,432,464	87,387,464	(+)2,045,000
Contained WO₃	144,650.07	142,094.35	(+)2,555.72
Andhra Pradesh			
Ore	148,02300	14,802,300	No Change
Contained WO ₃	20,262.57	20,262.57	No Change
Haryana			
Ore	2,230,000	2,230,000	No Change
Contained WO ₃	3,568	3,568	No Change
Karnataka			
Ore	36,677,818	36,677,818	No Change
Contained WO ₃	6,235	6,235	No Change
Maharashtra			
Ore	10,122,250	8,077,250	(+)2,045,000
Contained WO ₃	18,590.72	16,035	(+)2,555.72
Rajasthan			
Ore	23,928,294	23,928,294	No Change
Contained WO ₃	93,707.94	93,707.94	No Change
Tamil Nadu			
Ore	250,000	250,000	No Change
Contained WO ₃	50	50	No Change
Uttarakhand			
Ore	658,000	658,000	No Change
Contained WO ₃	705	705	No Change
West Bengal			
Ore	763,802	763,802	No Change
Contained WO ₃	1,530.84	1,530.84	No Change

figures rounded off.

Table - 3 : District wise Reserves/Resources of Tungsten as on 01.04.2020

(In Tonne)

State	District	Reserves	Remaining Resource	Total Resources
All India : Total				
Ore		-	89,432,464	89,432,464
Contained WO₃		-	144,650.07	144,650.07
Andhra Pradesh				
Ore		-	14,802,300	14,802,300
Contained WO₃		-	20,262.57	20,262.57
	Godavari (East)			
	Ore	-	14,802,300	14,802,300
	Contained WO ₃	-	20,262.57	20,262.57
Haryana				
Ore		-	2,230,000	2,230,000
Contained WO₃		-	3,568	3,568
	Bhiwani			
	Ore	-	2,230,000	2,230,000
	Contained WO ₃	-	3,568	3,568
Karnataka				
Ore		-	36,677,818	36,677,818
Contained WO₃		-	6,235	6,235
	Gadag			
	Ore	-	300,000	300,000
	Contained WO ₃	-	360	360
	Kolar			
	Ore	-	33,675,889	33,675,889
	Contained WO ₃	-	4,392	4,392
	Raichur			
	Ore	-	2,701,929	2,701,929
	Contained WO ₃	-	1,483	1,483
Maharashtra				
Ore		-	10,122,250	10,122,250
Contained WO₃		-	18,590.72	18,590.72
	Nagpur			
	Ore	-	10,122,250	10,122,250
	Contained WO ₃	-	18,590.72	18,590.72
Rajasthan				
Ore		-	23,928,294	23,928,294
Contained WO₃		-	93,707.94	93,707.94
	Nagaur			
	Ore	-	23,775,123	23,775,123
	Contained WO ₃	-	93,179	93,179

(Contd.)

National Mineral Inventory - An Overview

Table-3 (Concl.)

State	District	Reserves	Remaining Resources	Total Resources
	Sirohi			
	Ore	-	153,171	153,171
	Contained WO ₃	-	528.94	528.94
Tamil Nadu				
Ore		-	250,000	250,000
Contained WO₃		-	50	50
	Madurai			
	Ore	-	250,000	250,000
	Contained WO ₃	-	50	50
Uttarakhand				
Ore		-	658,000	658,000
Contained WO₃		-	705	705
	Almora			
	Ore	-	658,000	658,000
	Contained WO ₃	-	705	705
West Bengal				
Ore		-	763,802	763,802
Contained WO₃		-	1,530.84	1,530.84
	Bankura			
	Ore	-	763,802	763,802
	Contained WO ₃	-	1,530.84	1,530.84

figures rounded off.

5.8 VANADIUM

Introduction

Vanadium is a rare element even though its concentration in earth's crust is more than those of some common metals. It occurs in trivalent form; i.e. V^{+++} in the earth's crust but it being geochemically similar to trivalent iron; i.e., Fe^{+++} , it generally substitutes the ferric iron and consequently forms few minerals of its own. Thus, there is a direct relation between vanadium and iron. It occurs in association with titaniferrous magnetite and recovered as a by-product during iron and steel manufacture. Vanadium is also concentrated in many end-products of organic material including coal and oil. In addition, vanadium present in bauxite can also be recovered as vanadium sludge from red mud during the production of aluminium. On an average, it contains 0.26 to 0.4 per cent V_2O_5 .

Basis of Grade Classification

Vanadium ore as mined is not used directly in the industry. Therefore, the end use classification at the time of resource estimation is not possible. Hence in the inventory as on 01.04.2020, resources have been continued to be classified as ore and its metal content as V_2O_5 .

Basis of Categorisation of Resources

As per United Nations Framework Classification (UNFC) resources have broadly been classified into 'reserves' and 'remaining resources'.

According to the norms of this system, the remaining resources have been placed under feasibility (211), pre-feasibility (221) & (222), indicated (332) and inferred (333) categories.

Salient Features of the Inventory

The total resources of vanadium ore in the country as on 01.04.2020 are estimated at 24,633,855 tonnes having 64,594.01 tonnes of metal. The entire 24,633,855 tonnes of ore containing

64,594.01 tonnes of metal are in Remaining Resources category.

All India scenarios of vanadium reserves, remaining resources and total resources as on 01.04.2020 vis-à-vis 01.04.2015 have been given in Tables - 1 and 2. The Tables give an idea about changes in terms of increase or decrease of resources as per lease status, grade and state. In Table-3, district wise reserves/resources have been given.

Out of the total 24,633,855 tonnes of ore resources, 24,249,225 tonnes have been estimated in the freehold category and remaining 384,630 tonnes are estimated in the lease hold (public) category. The resources of vanadium ore have been estimated in the state of Karnataka, Maharashtra and Odisha. Out of these, Karnataka is credited with 19,384,430 tonnes (78.69%) of ore containing 49,497.55 tonnes of metal followed by Odisha with 4,864,795 tonnes (19.75%) of ore containing 13,557.94 tonnes of metal and Maharashtra with 384,630 tonnes (1.56%) of ore having 1,538.52 tonnes metal.

There is no change in the resource position of vanadium as compared to previous inventory as on 01.04.2015.

About 18,297,225 tonnes resources of vanadium ore (74%) containing 54,133.29 tonnes of metal have been estimated under inferred (333) category. These estimates are based on a limited and preliminary exploration. If these areas are examined for further detailed exploration the confidence level of the vanadium resources in the country may improve.

A total of 24 deposits of vanadium have been covered in NMI as on 01.04.2020. Out of which 23 deposits are in freehold and 1 deposit is in leasehold (public) areas.

**Table - 1 : Reserves/Resources of Vanadium as on 01.04.2020 vis-à-vis 01.04.2015
(By Lease Status/Grade)**

Lease status/Grade	Reserves		Remaining resources		Total resources		(In Tonnes)
	01.04.2020	01.04.2015	01.04.2020	01.04.2015	01.04.2020	01.04.2015	
	Net change		Net change		Net change		
All India : Total							
Ore	-	-	24,633,855	24,633,855	No change	24,633,855	No change
Contained V₂O₅	-	-	64,594.01	64,594.01	No change	64,594.01	No change
Freehold							
Ore	-	-	24,249,225	24,249,225	No change	24,249,225	No change
Contained V₂O₅	-	-	63,055.49	63,055.49	No change	63,055.49	No change
Leasehold (Public)							
Ore	-	-	384,630	384,630	No change	384,630	No change
Contained V₂O₅	-	-	1,538.52	1,538.52	No change	1,538.52	No change

figures rounded off.

**Table – 2 : Total Resources of Vanadium as on 01.04.2020 vis-à-vis 01.04.2015
(By States)**

State	Total Resources		Net Change
	(In Tonnes)		
	As on 01.04.2020	As on 01.04.2015	
Total			
Ore	24,633,855	24,633,855	No Change
Contained V₂O₅	64,594.01	64,594.01	No Change
Karnataka			
Ore	19,384,430	19,384,430	No Change
Contained V ₂ O ₅	49,497.55	49,497.55	No Change
Maharashtra			
Ore	384,630	384,630	No Change
Contained V ₂ O ₅	1,538.52	1,538.52	No Change
Odisha			
Ore	4,864,795	4,864,795	No Change
Contained V ₂ O ₅	13,557.94	13,557.94	No Change

figures rounded off.

Table - 3 : District wise Reserves/Resources of Vanadium as on 01.04.2020

State/	District	(In Tonne)		
		Reserves	Remaining Resources	Total Resources
All India : Total				
Ore		-	24,633,855	24,633,855
Contained V₂O₅		-	64,594.01	64,594.01
Karnataka				
Ore		-	19,384,430	19,384,430
Contained V₂O₅		-	49,497.55	49,497.55
	Hassan			
	Ore	-	904,430	904,430
	Contained V ₂ O ₅	-	1,840.55	1,840.55
	North Kanara			
	Ore	-	5,150,000	5,150,000
	Contained V ₂ O ₅	-	21,058	21,058
	Shimoga			
	Ore	-	13,330,000	13,330,000
	Contained V ₂ O ₅	-	26,599	26,599
Maharashtra				
Ore		-	384,630	384,630
Contained V₂O₅		-	1,538.52	1,538.52
	Gondia			
	Ore	-	384,630	384,630
	Contained V ₂ O ₅	-	1,538.52	1,538.52
Odisha				
Ore		-	486,4795	4,864,795
Contained V₂O₅		-	13,557.94	13,557.94
	Balasore			
	Ore	-	73,920	73,920
	Contained V ₂ O ₅	-	236.54	236.54
	Mayurbhanj			
	Ore	-	4,790,875	4,790,875
	Contained V ₂ O ₅	-	13,321.40	13,321.40

figures rounded off.