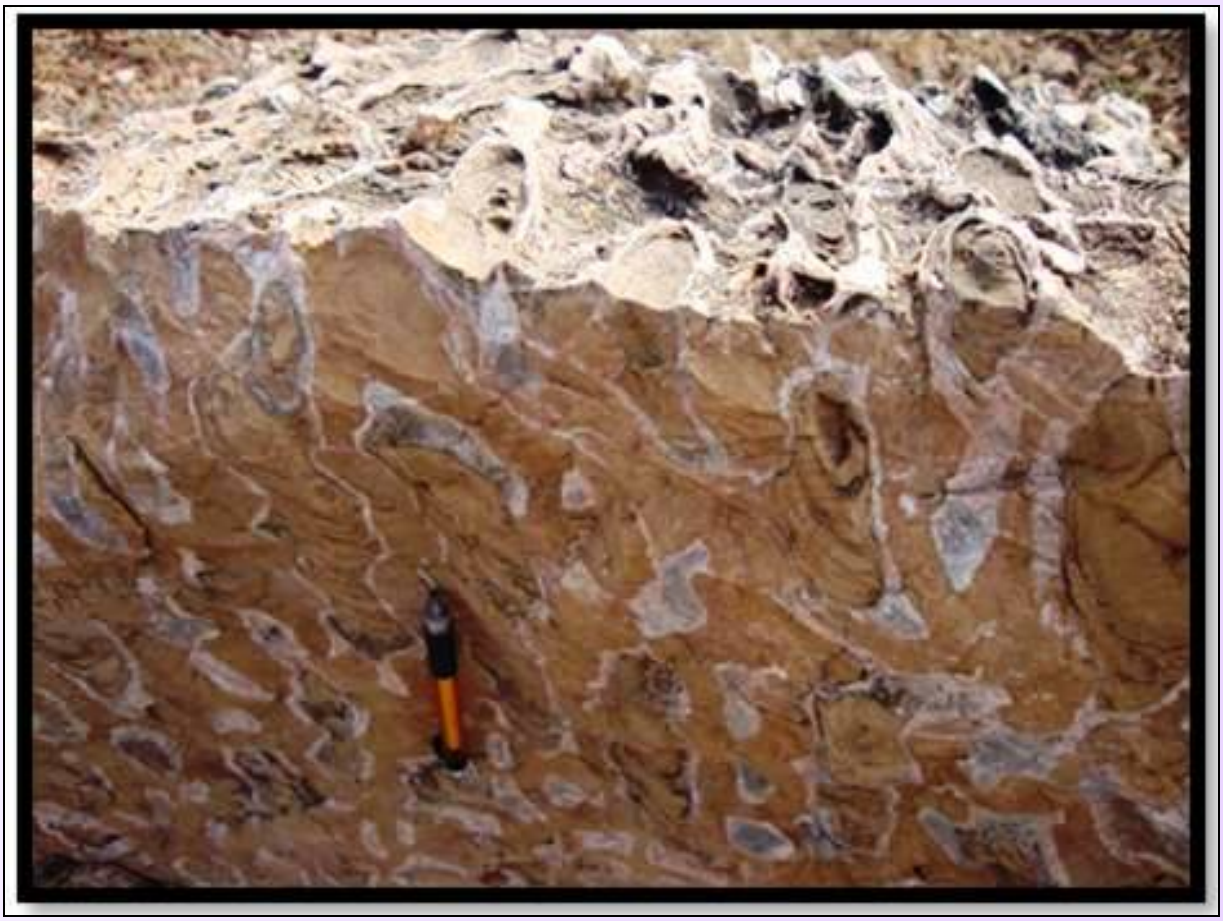
GEOLOGICAL SURVEY OF INDIA

CGPB-COMMITTEE- IV
INDUSTRIAL & FERTILIZER MINERALS

BASE DOCUMENT



NAGPUR
2011

CGPB – COMMITTEE: IV

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BASE DOCUMENT

FRONT COVER PHOTO: Stromatolite, North Khatama Block, Jhabua District, M.P.

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CHAPTER- I

Introduction

The Central Geological Programming Board (CGPB) was established on 27th July 1966. The CGPB was constituted primarily to co-ordinate activities on geological mapping and mineral prospecting, exploration and exploitation in the country, with the Geological Survey of India (GSI) as the nodal department and the State Geology and Mining departments and Central Government institutions as the participating members. The emergence of a large number of newly established Central and State level organizations as well as research institutions in the scientific sector have also added urgency to the necessity of revamping of the CGPB mechanism.

It has accordingly been decided to reconstitute the Central Geological Programming Board and its Subcommittees to provide for better coordination between Central and State level stakeholders by encouraging the regular functioning of State Level Geological Programming Boards, setup by the State Governments to achieve the requisite synergy.

The Central Board shall be supported by 12 Committees for the various sub-sectors and the activity of Industrial and Fertilizer Minerals programmes shall continuously be monitored by Committee IV.

Terms of Reference:-

Committee- IV of the CGPB were reconstituted with the following terms of reference;

1. To formulate annual and five year plans for regional, detailed and promotional Exploration of fertilizer minerals on a national scale.
2. To review the work done so far relating to the activity domain of the Committee including the ongoing programs along with utilization of budget of promotional exploration schemes sponsored by different Ministries of Government of India .
3. To coordinate the exploration work by Government, Public and Private Agencies as per the defined plan objectives and priorities.
4. To facilitate and promote partnership between Central and State organizations and Public – Private partnership in exploration.

5. To prepare status papers, long/short term perspective plans, updating manual of end-users specifications keeping in view progressive advancement of knowledge and technology.

6. To prepare and update the database (including status map) of all regional and detailed exploration involving Central, State and private agencies.

7. To ensure data filing by the concession holders engaged in regional exploration as per rule, and monitor its availability in public domain after lock-in period through an identified system.

8. To prioritize Research & Development work in the mineral sector related to exploration techniques, modernization of field/sampling equipments and beneficiation.

9. To advise Government on human resource development and training of personnel in order to strengthen the manpower of Central and State organizations.

Functions of Committee IV:

- Short and long term plans, in accordance with the prevailing national priorities, are formulated and executed by involving Central and State agencies and Public and Private entrepreneurs.
- Regular monitoring and coordination of exploration activities of all concerned agencies are carried out for optimal utilization of available resource base and to avoid any overlap or duplication of work component. Simultaneously judicious utilization of budget on promotional exploration schemes is also ensured through regular monitoring.
- Multi-disciplinary available database are collated and synthesized for formulating fruitful future exploration strategies.
- Sharing of data/ knowledge base amongst all concerned agencies are being done for prognostication of potential areas.
- Compilation of industrial and fertilizer mineral resource database of the country and annual updating of National Inventory through active interaction of the committee members.
- As per requirement, Expert Committees are constituted to address both technical and administrative issues.
- Regular meetings of the Core Committee are convened to discuss specific agenda on national perspective as well as to develop close interactions amongst the National agencies to meet the commitment by extending mutual support. Availability of expertise and resource base is also discussed to meet the requirement of State and other agencies.
- Biannual meetings have long been practiced for smooth functioning of the Committee.

Participating Members of Committee IV:

Convener : Sr. Dy. / Dy. Director General, GSI, Central Region Office(CRO), Nagpur

Member Secretary: Director (Com. IV), GSI, CRO, Nagpur

Members:

1. Director, Ministry of Mines
2. Director, Ministry of Fertilizer
3. Director, Department of Industry
4. DGM, Govt. of Jharkhand
5. DGM, Govt. of Rajasthan
6. DGM, Govt. of Uttar Pradesh
7. CGM, Govt. of Gujarat
8. DGM, Govt. of Madhya Pradesh
9. DGM, Govt. of Meghalaya
10. DGM, Govt. of Maharashtra
11. DGM, Govt. of Jammu & Kashmir
12. DGM, Govt. of Andhra Pradesh
13. DGM, Govt. of Karnataka
14. DGM, Govt. of Orissa
15. DGM, Govt. of Tamil Nadu
16. DGM, Govt. of Kerala
17. DGM, Govt. of Himachal Pradesh
18. IBM
19. MECL
20. Dy. DG of operations and Directors of GSI associated with the items of Industrial and Fertilizer Mineral Group investigations, Director (Monitoring) and Director (CGPB), GSI, CHQ.

Permanent Invitées:-

i. RSMDC

ii. Representative of Cement Industry (ACC Limited)

iii. Pyrite Phosphate Chemicals Ltd., New Delhi

Increase in modern industrialization leads to additional mineral consumption by the industries such as steel, cement, fertilizers etc. Occurrence of a major mineral deposit in a backward area stimulates development of the area by way of development in infrastructure and improvement in employment opportunities.

India is blessed with ample mineral resources and there are still potential areas to be explored. Mineral Exploration Strategy is to be viewed in a long-term perspective. Small and isolated mineral deposits are scattered all over the country and by modest investment, these deposits can be mined through small scale mining. New prospects have to be explored and reassessment to be done on number of low grade deposits which are currently being considered commercially unviable even though they are exploitable with commercial success as per global standard.

The base line geoscience data generation carried out by GSI so far has resulted in identification of potential areas. The country requires much more sustained and serious efforts to augment the mineral resources.

Geologically the country is represented by litho units ranging in age from Archaean to Recent. The litho units of similar age, in different areas are of diverse nature causing uneven distribution of mineral distribution. Nevertheless the Archaean rocks in India are the store house of mineral wealth of iron ore, gold and volcanic related massive sulphite deposits. The Archaean rocks are followed by litho units of Proterozoic age which hosts minerals like barite, limestone, dolomite, asbestos, tin, tungsten, manganese, marble, gypsum, phosphorite, graphite and refractories.

Status of Industrial and Fertilizer Mineral Resources

Abundant resources of limestone, dolomite, barite, calcite, fire clay, quartz, feldspar, garnet, gypsum, mica, magnetite, pyrophyllite, graphite, mica and silica sand are available in the country. But minerals like apatite, rock phosphate, sulphur, potash, diatomite and kyanite are in deficient quantity.

Highlights of the Four Meetings

(Meetings 1 to 4 of C G P B – IV)

After the reconstitution of CGPB with formation of 12 CGPB committees, the following 4 meetings were conducted with Deputy Director General and HoD, Central Region as the convenor of CGPB IV.

Sr. No.	CGPB IV Industrial and Fertilizer Minerals	Venue	Date
1.	1st Meeting	Nagpur	02. 07. 2009
2.	2nd Meeting	Nagpur	07. 12. 2009
3.	3rd Meeting	Nagpur	29. 06. 2010
4.	4th Meeting	Bhopal	29. 11. 2010

Highlights :-

1. Discussion: In the first meeting a Dossiers on Industrial and Fertilizer Minerals of the three states (Maharashtra, Madhya Pradesh & Chhattisgarh) of Central Region was distributed to the participants of CGPB IV. A decision was taken that the regions of GSI (including Marine Wing) would prepare such dossiers.

Action taken :- In the subsequent meetings the members from other Regions of G S I expressed the view that the Miscellaneous Publications (Geology and Mineral Resources) of each region (G S I) do contain the details on Industrial and Fertilizer Minerals of the respective regions, thus the same may be referred for future course of action.

2.**Discussion** :- Beneficiation of low grade Phosphorite deposits (< 10% P_2O_5) was discussed in most of the meetings of CGPB IV. The IBM has carried out beneficiation studies on low grade Phosphorite and results of some of the samples have been compiled in Chapter VII.

Action taken: - During F. S. 2009 – 11 Op. Mah. : Madhya Pradesh and Chhattisgarh have carried out Phosphorite investigations and samples have been collected for submission to I B M for beneficiation studies.

3. Discussion :- In the 1st and 2nd meetings there were discussions and decision that a training programme to be arranged on Exploration for Fertilizer Minerals for young Geologist (G S I and State DGM)

Action taken :- As a follow up action RTI, CR Conducted a training programme on "Techniques of exploration for fertilizer minerals" from 16.2.11 to 20.2.11 at Jhabua (MP).

CHAPTER- II

Industrial and Fertilizer Minerals

I Industrial Minerals

a) **Limestone** – $CaCO_3$: It is a sedimentary rock composed of mainly calcium carbonate and they are seldern pure contain $CaCO_3$ up to 75 percent. Limestone occurs as crystalline and amorphous limestone and may be argillaceous, ferruginous and fossiliferous. Limestone occurs with the rocks of Cuddapah system as Vempalle Limestone and Vindhyan system as Vindhyan Limestone. It is used as a raw material for manufacture of Cement and Fertilizer.

b) **Dolomite**-$CaMg(CO_3)_2$: It is a sedimentary rock composed of high Magnesium Limestone. They are formed when Calcium Carbonate of limestone is replaced by Magnesium ions. It is used in the manufacture of Cement, refractory, rubber, ceramic and chemical industries.

c) **Refractories** :

Kyanite – Al_2SiO_5 : It is one of the alluminosilicate, characterised by bluish white coloured, bladed and platy with variable Hardness (4.5 along the length and 7 along the width plane). It is used as a refractory non-plastic mineral and it occurs in regional metamorphic schist and gneisses together with garnet, quartz, staurolite and mica.

Sillimanite – $Al_2 SiO_5$ –is greyish white coloured mineral and contains about 63% of Al2O3. It is used in ceramic, refractory, and electrical industries. It is occurs in schist and gneisses of high grade regional metamorphism.

Pyrophyllite – $Al_2 Si_4 O_{10} (OH)_2$ – is used in ceramics and talcum powder. Pyrophyllite is also extensively used in insecticides, such as DDT.

Graphite-C: It is dark grey coloured, characteristic greasy feel, low hardness (1.5 to 2.5) low specific gravity (2.1) and metallic luster. It is occurs as flakes in sedimentary rocks, limestoned metamorphic rocks (Schist, Gneisses, and Khondalite) and igneous rock (Pegmatite, syenites, and granites). Graphite occurs as beds, veins, and pocket deposit. Graphite occurs in Archaean and Dharwarian rocks such as Khondalite and associated gneisses and in pegmatite. It is used in manufacture of Refractory carbon brick, crucible, because of its anti-corrosive nature and high melting point (3000 °C)

Magnesite-$MgCO_3$ – It is white colour, massive to granular rock. It is occurs as veins, lenses, tabular masses and patches in ultra-basic rocks of Archean age. It occurs in solution in

sea water and mineral waters. In India it is occurs in Tamil Nadu, Karnataka, Uttar Pradesh, Andra Pradesh, Bihar, Gujarat and Rajasthan. It is used for extraction of magnesium metal, for manufacture of magnesium alloys, refractory bricks, special cement, magnesium salt. It is also used in the production of carbon dioxide, chemical salt, crucibles, furnace lining in the sugar and paper industries.

Fire Clays: These are also known as sedimentary clays, residual clays or refractory. It contain low percentage of iron oxide, magnesia, lime and alkalies and can withstand high temperature (> 1550˚C). Fire clays are found in association with Gondwana rock like coal, sandstone and shale. Best qualities of Fire clays are found in coalfield of West Bengal, Bihar, Madhya Pradesh and Andra Predesh. Fire clays are used in the manufacture of firebricks, pipes, sanitary ware, retorts, fire blocks, crucibles, bath tubes, etc.

Clays – It is a natural substance consisting chiefly of hydrous alumino silicic acids with colloidal materials and impure rock fragments. Clays are found as weathered metamorphic rocks of Archaean and Precambrian age. Clay deposits are found in association with Gondwana rocks. The clays mineral occurs as very minutes lath like flacky, hallow-tube-shaped or fibre like crystals. These clays occur as transported clays, residual clays and colluvial clays etc. Clays are used in ceramic (for manufacture of chinaware, porcelain) and refractory industries (for manufacture of fire bricks, retorts, sanitary wares etc). Bentonites (type of clay) used in ceramic and porcelain industries, in the manufacture of bleaching powder, vegetable oil refining, petroleum refining, sap, glycerin and cosmetics.

d) **Quartz**-SiO_2: It is the most abundant mineral of all rocks, mostly found in acid igneous rocks, quartzites, sandstones and as sand. Quartz occurs as massive crystalline, crystal and veins. Quartz is found in pegmatite, granites, sandstone etc. It is used in ceramic industry, in making enamel, silicon alloy, silicon ferro-silicon carbide, sodium silicate, etc.

Feldspar-$KAlSi_3O_8$: It is the most abundant of the rock forming minerals. They are two main classes: (i) Potash-feldspar (Orthoclase) and (ii) Sodium feldspar (Plagioclase-albite and anorthite). Feldspar occurs in igneous rocks of Archaean and Precambrian rocks. Feldspar occurs mostly in igneous rock like pegmatite and granites. It is used for the manufacture of pottery, glass, enamel, artificial teeth.

Mica: It is an important group of rock forming minerals, composed of chiefly orthosilicates of aluminium with potassium, magnesium, iron with hydrogen and sometime vanadium, lithium chromium, etc. Pegmatite bearing mica deposits usually occurs in the Precambrian rocks and mica schist of Dharwar age in Archaean formations. Mica is used in the manufacture of electrical insulators, quartz-wedge plate.

Wollastonite : It is a calcium inosilicate mineral ($CaSiO_3$) that may contain small amounts of iron, magnesium, and manganese substituting for calcium. It is usually white. It forms when impure limestone or dolostone is subjected to high temperature and pressure sometimes in the presence of silica-bearing fluids as in skarns or contact metamorphic rocks. Associated minerals include garnets, vesuvianite, diopside, tremolite, epidote, plagioclase feldspar, pyroxene and calcite. It is used mostly by tile factories.

Vermiculite: It is a hydrated magnesium silicate. It occurs in laminae, tabular and granular forms. The laminae in general soft, in elastic and pliable. It forms when the ultra basic igneous rock is attacked by the hot gaseous solutions. It is used for insulation, making hydrofluoric acid and Portland cement.

Zeolites: These are hydrous silicates of calcium and aluminium, sometime sodium and potassium; hardness varies from 3.5 to 5.5. These are occurs as filling in the amygdular cavites in deccan trap basalts in Maharashtra, Gujarat, Madhya Pradesh and Karnataka. Zeolites occurs as secondary minerals, cavity filling, cracks, fissure, in rock like basalt, lava etc. these are used in chemical industry.

e) **Garnets**: These are silicates of various metals and fairly hard (H. 6.5 to 7.5) and have specific gravity of 3.4 to 4.3. It occurs as common accessory minerals of igneous rocks such as pegmatite, garnets, syenites and metamorphic mineral in schist, gneisses, crystalline limestones or marbals. It is used as semi-preseious stone, gemstone and as abrasive.

Asbestos: These are of spinning and non-spinning fibers. The term asbestos is applied for number of fibrous minerals that can be easily split into fibres. Asbestos occurs in serpentine bearing rock such as dunites, peridotite, etc. Amphibolite asbestos occurs as slip-fiber or mass

or mass fiber associated with schist and gneisses. Asbestos occurs in Archaean rocks associated with basic and ultra basic rocks. It is used in manufacture of heat-insulating cement, asbestos paper, block, sheet, paint etc. The non- spinning fiber asbestos are used in making asbestos cement.

Ilmenite: Ilmenite has been found in Moon rocks, and is typically highly enriched in magnesium similar to the kimberlitic. Ilmenite is the primary ore of titanium. It is also used in the manufacture of titanium dioxide for paint pigments. Titanium is used to manufacture a wide variety of metal parts where light weight and very high strength are needed. Examples include: aircraft parts, artificial joints for humans and sporting equipment such as bicycle frames

Fluorite: It is fluoride of calcium, pale blue, pale violate, green, yellow or colour less. It occurs in pneumatolytic and hydrothermal veins as cubic and octahedron crystals, usually associated with quartz, galena, barite and calcite. It is used in ceramic and glass industries, in making paints, hyderothermal, acid, optical glass, opaque glass, plastic etc.
Steatite: (also known as Soapstone or soaprock) it is a metamorphic rock, a talc-schist. It is largely composed of the mineral talc and is thus rich in magnesium

f) **Barite-** Ba SO_4 – It is a white coloured, opaque to translucent mineal. It occurs as veins in the gneisses, fissure veins along with joints, fault, and bedding planes in quartzite and is found in association with limestone, sandstone, shale, dolomite etc. It is used in chemical, paint and textile industries.

g) **Dimensional stone-** is natural stone or rock that has been selected and fabricated (i.e., trimmed, cut, drilled, ground, or other) to specific sizes or shapes. Color, texture and pattern, and surface finish of the stone are also normal requirements Dimension stone has been used in the construction of buildings, road construction, statue, monuments.

II Fertilizer Minerals:-

a) **Phosphorite** – The source of phosphate are, Phosphatic limestone, Phosphetic marls, phosphate beds in the marine precipitate of great economic importance and raw material for phosphate fertilizer.

b) **Apatite** – $Ca_5 (PO_4)_3$ (F, Cl, OH) : it is calcium phosphate with varying amounts of F, Cl and (OH), viz. and of variable coloured, hard (H 5) with moderate specific gravity (3). Apatite occurs as veins and lenses. It occurs in mica- pegmatite, apatite, magnesite and chlorite rocks of Archaean age. It is used for the manufacture of superphosphate and other phosphate compounds used for fertilizer, it also used in making of phosphorus, ceramics, glass, photography, dental cement and textile industries.

(i) Fluorapatite. . It is a mineral with the formula $Ca_5 (PO_4)_3F$ (calcium fluorophosphate), in which 'F' predominates. Fluorapatite is a hard crystalline solid. Although samples can have various color (green, brown, blue, violet, or colorless), the pure mineral is colorless as expected for a material lacking transition metals. It occurs widely as an accessory mineral in igneous rocks and in calcium rich metamorphic rocks. It commonly occurs as a detrital or digenetic mineral in sedimentary rocks and is an essential component of phosphorite ore deposits. Industrially, the mineral is an important source of both phosphoric and hydrofluoric acids.

(ii) Chorapatite – in which 'Cl' predominates

(iii) Hydroxylapatite – it is also called hydroxyapatite (HA), is a naturally occurring mineral form of calcium apatite with the formula $Ca_5 (PO_4)_3(OH)$, in which (OH) predominate and is used in superphosphate fertilizer.

c) Gypsum $CaSO_4\ 2H_2O$ –It is a hydrous calcium sulphate. It is a soft (H 2) and light (Sp.gr. 2), colourless to white coloured, fibrous or massive mineral. It occurs as bedded deposits, with sedimentary rocks such as limestone, shale, sandstone, etc. as veins, grains and nodules in marine silts. It is used as Fertilizers industry, cement, paint, rubber and paper industries.

d) Glauconite: - $K (Fe, Mg, Al)_2 (Si_4 O_{10}) (OH)_2$ – It is a hydrous silicate of iron and potassium with aluminium and magnesium. Glauconite is one of the raw materials in fertilizer industry.

CHAPTER- III

Industrial and Fertilizer Minerals- Indian Scenario and Requirements

The non-metallic industrial minerals give an anchoring lift and support to the metallic industrial world.

Agriculture continues to be the mainstay for livelihood of rural people of India and is the backbone of Indian economy because of its high share in employment. Fertilizer is considered as an essential input to Indian agriculture for meeting the food grain requirement of the growing population of the country. Today, India is the third largest producer of the nitrogenous fertilizer in the world after China and USA. The consumption of fertilizers in the country has been showing an appreciable growth in last few years. The production of fertilizer needs to be further increased to meet our increasing requirement of food in the country. Government is committed to provide adequate fertilizer at affordable price so that farmer does not face shortage of this critical input. Due to raw material shortage, India needs to import substantial quantities of phosphatic raw material and Diammonium phosphate (DAP).

It is the need of the hour to view mineral exploration strategy in a long term prospective. There are small and isolated mineral deposit scattered all over the country. Therefore, ***Sustainable development*** with modest investment is the need of the day. So that these deposits can be mined through small scale mining. New prospects are to be explored and reassessment done on a number of low grade deposit which are currently considered commercially unviable even though they are exploitable with commercial success as per global standard.

Mineral resources are the backbone of industrial development and mineral production plays a significant role in national economy. The limited and near exhaustive resources to the proximity of earth surface dictates us to adopt multidisciplinary and futuristic approach in mineral exploration further below the earth's surface. Unmindful mining of a particular mineral will lead to disaster. So it is pertinent to explore more areas for additional resources to meet present demand and preserve for future generations. Presently mineral search and assessment is being undertaken with special emphasis on deficient commodity of high value as well as ores and minerals of high demand.

Departmental Co-ordination

Regular exchange of data and knowledge base amongst the concerned National and State Agencies as well as public and private entrepreneurs and academic institutions, under the aegis of the CGPB Committee-IV is very important in the national perspective for getting the success in the on-going programmes and delineation of future prospective areas.

International Cooperation

In the light of fast moving world of geoscientific scenario bilateral arrangement, particularly with countries having state of art exploration technology is the need of the day for acquisition of knowledge base and development of skill.

Research and Development

1. Indigenous technology has to be upgraded through research and appropriate absorption and adoption of technological innovations abroad. Research and development efforts shall be made to improve efficiency in process, operations and also the recovery of by-products and reduction in specification and consumption norms. Efforts will also be directed to evolve low capital and energy saving processing systems.
2. Research and development in the mineral sector has to cover the entire gamut of activities from geological survey, exploration, mining, beneficiation, extraction of minerals to development of materials.
3. Appropriate technologies shall be developed to enable indigenous industries to utilize the mineral resources with which the country is abundantly endowed and as substitutes for minerals whose reserves are poor.
4. Research and development shall be oriented to ensure maximum economic recovery of the associated minerals and valuable metals.

Co-ordination of Research Organizations

Pooling of resources and expertise available in the various R&D Organizations is imperative to meet the challenges and to fulfill the tasks ahead in the mineral sector Research and development activities in the mineral sector are carried out in the educational institutions, national laboratories and R&D units of public and private sector enterprises. Linkages and

interaction between the various institutions engaged in R&D in the mineral sector shall be strengthened to derive the maximum benefit.

CHAPTER- IV

Resources of Industrial and Fertilizer Minerals

[As per Indian Minerals year book 2008- IBM]

LIMESTONE

The total categories and grade as per UNFC system as on 1.4.2005 is estimated at 175,345 million tonnes, of which 12,715 million tonnes (7%) are under reserve category and 162,630 million tonnes are under resources category.

The production of limestone ammoniated to 204 million tonnes in 2008-09 (increased by 6 million tones as compared to that in the previous year 2007-08). As much as 88% of the total output in 2008-09 was contributed by seven principal states; viz, Andhra Pradesh (22%) Rajasthan (18%), Madhya Pradesh (13%), Gujarat (11%) and Tamilnadu, Chhattisgarh and Karnataka (8% each). The other limestone producing states shared the remaining 12% of the total production.

DOLOMITES

As per UNFC system, as on 1.4.2005 total resources of dolomites are placed at 7,533 million tonnes, out of which 985 million tonnes are placed under reserves category and balance i.e. 6,548 million tonnes under resource category. Grade wise BF/sintering grade accounts for 30% followed by SMS (20%), refractory (6%), BF and SMS mixed (4%) and glass (3%) and other remaining unclassified grade (37%). The production of dolomites in 2007-08 is 5.11million tonnes.

KYANITE &SILLIMANITE

The total resources of kyanite as per UNFC system is placed at 102.6 million tonnes. The total resources of the sillimanite as per UNFC system in the country as on 1.4.2005 are placed at 74 million tonnes. Out of these resources, the reserves are only 11 million tonnes, while about 63 million tonnes are remaining resources. Out of the total resources more than 74% are granular high–grade, while quartz sillimanite rocks and sillimanite bearing rocks are about 20 percent. Resources of massive sillimanite of all grades are about 5 percent.

The production of sillimanite at 42566 tones in 2007-08 registered an increase of 61% as to that of previous year.

GRAPHITE

As per as UNFC system, the total resources of the graphite as on 1.4.2005 are placed about 168.77 million tonnes comprising 10.75 million tonnes in the reserve category and 158.02 million tonnes under the remaining resource category. Production of graphite at 116 thousand tonnes in 2007-08 registered a decrease by 29% as compared to that of preceding year. The output of the graphite reported in terms of run–of–mines (r.o.m.) contains varying carbon content.

MAGNESITE

The total reserve/resources of magnesite as per UNFC system as on 1.4.2005 are about 338 million tonnes of which reserves and remaining resources are 76 million tonnes and 262 million tonnes, respectively .Substantial quantities of resources are established in Uttarakhand (68%), followed by Rajasthan (16%) and Tamil Nadu (13%). Resources are also located in Andhra Pradesh, Himachal Pradesh, Jammu & Kashmir, Karnataka and Kerala. Production of magnesite in 2007-08 was 248 thousand tonnes.

QUARTZ

As per the UNFC system as on 1.4.2005, the total resources of quartz and silica sand in our country are estimated at 3,238 million tonnes out of which 24% i.e. 771 million tonnes are placed under reserves category while 76% i.e. 2,467 under the resources category.

Resources of foundry and moulding grades are (20%), glass grade (10%), and ceramic & pottery grade (10%) and ferrosilicon grade(6%). About 53%resources are of unclassified grade. Haryana alone accounts for 56% resources followed by Rajasthan (8%), Jharkhand (5%), Maharashtra (5%), Andhra Pradash (5%), Kerala (4%), Gujarat (3%), Uttar Pradesh (3%) , Karnataka (2%) and Orissa (2%).

The total resources of quartzite in the country as per UNFC system as on 1.4.2005 are estimated as 1,145 million tonnes of which reserves are 99 million tonnes and remaining resource are 10,406 million tonnes. The production of silica sand at 3.93million tonnes in 2007-08 increased by about 48 % over previous year. Andhra Pradesh the major producing State of silica sand reported an increase of 136 % incomparison with previous year. Production of Quartzite at 94 thousand tonnes in 2006 –07 decreased by 14% compared to that of previous year. The production of quartz at 233 thousand tonnes in 2006 –07 decreased

by 23% as compared to that of preceding year due to non –availability of labours and development works.

D G M TAMILNADU

[Suggestions by the department of geology and mining, state of Tamil Nadu]

SILICA SAND

The Silica Sand is an important raw material for manufacturing various types of Glass. It is also used in the industries for making Moulds and Cast for metal foundries, as abrasive mineral, locomotive industries, furnaces etc.

The specification of Silica Sand for Glass manufacturing is based on the SiO_2 content. In Glass industry, the quality of the Glass is classified from first quality to ninth quality and the SiO2 content of the Silica Sand required for the above purpose is from 99.8% to 95%. The Silica Sand is used in Foundry and Moulding Industries. The Silica Sand used in the above industries should be permeable to allow the evolved gases to escape during Casting and should allow the metal to get into all follows of the Mould. The specification for this purpose is 90% to 98%.

DISTRIBUTION:

Large quantity of Silica Sand is found to occur in Nagapattinam, Villupuram, Kancheepuram, Cuddalore and Thiruvallur Districts. Though investigations were carried out by the Department of Geology and Mining and Geological Survey of India for estimating the reserves and the quality of Silica Sand as early in the year 1977, in view of the increasing demand for the high grade Silica Sands for manufacturing of Glassware, Foundry and Moulding industries and for the manufacturing of Sodium Silicate etc. it is considered necessary that the present status of the Silica Sand occurrence in the State of Tamil Nadu has to be re-examined for detailed exploration to ascertain the quality and reserves of Silica Sand so as to enable the existing industries for their expansion and to increase the production capacity and also to encourage the new entrepreneurs to come forward to establish the new Industries to utilize Silica Sand as raw material.

In this regard it is pertinent to point out that the Silica Sand available in the mines of Neyveli Lignite Corporation is being dumped as waste along with the over burden material. Though the Sulphur content of the Silica Sand of Neyveli is around 0.5%, this can be purified

by chemical treatment and the Silica Sand can be exclusively used for Glass manufacturing in Neyveli itself. Hence, a detailed study on the occurrence, reserves, quality, method of separation from the other waste materials has to be carried out in detail in order to conserve the potential Silica Sand deposit available in the Neyveli Lignite Corporation mines and for better utilization in the existing or new coming Industries.

ORDINARY RIVER SAND

Though the ordinary River Sand is being used mostly in construction activities, it is also being used in various Industries as an alternative of Silica Sand viz. in Glass manufacturing, Foundry, Moulding Industries etc. The ordinary River Sand should be clean without much Clay, Mica and other impurities. As a result of extensive survey and research, carried out by many organizations, the white variety of sand available at Ennore, has been found suitable for use as a Standard Sand. Thoroughly washed Sand should pass 850 micron I.S. sieve and retained on 600 micron I.S. sieve.

Though the ordinary River Sand is available in large quantity in almost in all the River courses of the State, due to eco-sensitive and environmental aspects most of the sand deposit available in the river courses could not be exploited both for the construction purposes and also for the above Industrial use. Moreover in order to preserve the ecology and the environment of the River systems and depletion of ground water due to sand quarrying, quarrying of sand in some of the river systems has been banned. In view of this, there is a gap between the demand and the supply of sand in the State.

In this connection it is mandatory on the part of the State Department and the Geological Survey of India to find out an alternate to the River Sand. **"Machine Sand"** is being produced from white colour granites and the same is being used as an alternate for sand both in the construction as well as in the Industrial activities. In view of this, it is suggested that a detailed study to identify the rocks which are suitable for manufacturing **"Machine Sand"** has to be carried out in order to meet out the requirement of Sand. This work can be carried out jointly by the Department of Geology and Mining, Tamil Nadu and Geological Survey of India.

FELDSPAR

As per UNFC system, the total resources of feldspar in the country as on 1.04.05 are estimated at about 91million tonnes of which 38 million tonnes (42%) are reserves and 53 million tonnes (58%) remaining resources. By states, Rajasthan alone accounts for about 62% of total resource followed by Tamil Nadu (10%) Bihar and West Bengal 5% each.

The production of the feldspar at 411 thousand tonnes in 2007-08 decreased by 14% as compared to the preceding year.

MICA

As per UNFC system , the total resources of mica in the country as on 1.4.2005 are estimated at 393,855 tonnes out of which 68,570 tonnes are placed under reserves category and 325,285 tonnes under remaining resources category. Rajasthan leads with 51% share of the total resources followed by Andhra Pradesh (28%), Maharashtra (17%), Bihar (3%) and Jharkhand (1%). Most of the mica –bearing pegmatites occurs in Andhra Pradesh, Bihar, Jharkhand, Maharashtra and Rajasthan.

The production of the mica (crude) at 1,411 tonnes in 2006-07 decreased by about 33% as compared to the preceding year due to narrow and non productive pegmatite and closer of some mines due to forest law violation. The production of mica (crude) at 1242 tonnes in 2007-08 decreased by 12% compared to that of previous year. The contribution of Andhra Pradesh was 97% of the total production of the mica (waste and scrap) followed by Rajasthan 3 percent.

VERMICULITE

The total resources of vermiculites as on 1.4.2005 as per UNFC system is placed at 2.44 million tonnes of which more than 72% are placed under reserves category. Major resources are located in Tamil Nadu (77%), followed by Madhya Pradesh (11%), Andhra Pradesh (5%), Karnataka (4%), Rajasthan (2%), Jharkhand (1%). Production of vermiculite in 2007 –08 was 10,801 tonnes.

GARNET

The total resource s of garnet in India , as on 1.4.2005 , as per UNFC system is placed at 57.66 million tonnes of which reserve of proved and probable categories together are 20.98

million tonnes . Of the total resources, about 22.27 million tonnes are abrasive grade whereas resources of semiprecious grade are 9,465 tonnes only. Tamil Nadu alone accounts for more than 49% of the total resources followed by Andhra Pradesh 26% and Orissa 24% and the remaining state together share less than 1percent. Production of garnet (abrasive) during 2007-08 was 873 thousand tones.

ILMENITE

As per the UNFC, total resources of the titaniferous magnetite in the country as on 1.4.2005 are estimated at 40.68 million tonnes of which 1.29 million tonnes are placed under reserves category and bulk i.e. 39.39 million tonnes under "remaining resource" category . In addition , about 3.35 million tonnes resources of anatase are estimated in Meghalaya. GSI carried out seabed mapping and placer mineral investigations within the territorial water of India in 2005-06 through marine wing.

In 2007-08 the production of ilmenite was 678,772 tonnes. Tamilnadu is the leading producer of ilmenite contributing 51% of total production, followed by Orissa (30%) and Kerala (19%).

FLUORITE

As per the UNFC system, the total resources of fluorite in the country as on 1.4.2005 are estimated at 20.17 million tonnes. Out of these 9.21 million tonnes are placed under reserve category and 10.95 million tonnes under remaining resource category. Gujrat state having 13.39 million tonnes accounts for 69% of the total resources followed by Rajasthan 5.24 million tonnes (26%), Chattisgarh 0.55 million tonnes (2.7%) and Maharashtra 0.45 million tones (2.2%). The production of fluorite in 2007-08 was 7296 tonnes.

BARYTES

The total resources of barites in India as on 1.4.2005 as per UNFC system are placed at

74 million tonnes constituting 46%reserves and remaining 54% are resources. Andhra Pradesh alone accounted for more than 94% of country's resources of barytes.

The production of barytes at 1.07million tonnes in 2007-08 registered a decrease of 36% as compared to that of the previous year.

PHOSPHORITE/ROCKPHOSPHATE

The total resources of rock phosphate as per UNFC are placed at 305.3 million tonnes. The production of the phosphorite/ rock phosphate in 2007-08 was 1.86million tonnes. There were 4 reporting mines in 2007-08. Rajasthan continued to be the principal producing state,contributing 94% of the total production followed by Madhya Pradesh with 6%

Grade wise about 43% of the total production of phosphorite/ rock phosphate was of 30-35 % P2O5, 4% of 25-30% P2O5 and 53% of 15-20 % P2O5.

GYPSUM

As per UNFC system, the total resources of mineral gypsum in India as on 1.4.2005 are estimated at 1,237 million tonnes, of which 69 million tonnes are placed under reserves category and 1,168 million tonnes under remaining resources category. Of the total resources, fertilizer / pottery grade accounts for 79% and cement/paint grade 8 percent, unclassified grade 12 percent and remaining one percent by surgical plaster and soil reclamation grade.

The production of gypsum at 2.61 million tonnes in 2007-08 decreased by 13% as compared to that of previous year due to less demand and discontinuation of major mines as working permission was not granted for want of environmental clearance.

POTASH

As per UNFC system, total resources of potash as on 1.4.2005 are estimated at 21,815 million tonnes in the country. Rajasthan alone contributes (94%) resources, followed by Madhya pradesh (5%) and Uttar Pradesh the Remaining 1%.

For state wise resources on Industrial & Fertilizer minerals, the respective state DGM's website provides detailed information. (as an reference/example resources of Gujarat state is given below)

Industrial & Fertilizer Minerals

Mineral Reserves in Million tonnes in the state of Gujarat

Mineral	Reserves in Million tonnes
Bentonite	105
Calcite	0.0891
Chinaclay	162.83
Chalk	83.79
Diatomite	0.488
Dolomite	720.55
Fireclay	160.15
Fluorite	11.6
Graphite	2.135
Gypsum	3.376
Limestone	11897.14
Marble	259.6
Ochre	3.24
Quartz	11.474
Siderite	4.6
Silicasand	983.53
Steatite/Talc	0.007
Vermiculite	0.00196
Wollastonite	2.141

CHAPTER- V

Specific Project & Initiative

The fertilizer minerals are in deficient quantity and the Government spends crores of rupees on subsidy to the fertilizer industries. With this background the fertilizer minerals were taken-up for documentation under SPECIFIC PROJECT INTIATIVE.

Phosphate rock (>20% P_2O_5) is the primary source for the manufacture of phosphate fertilizers which sustain the modern day agriculture to a great extent. Phosphate rocks are commercially exploited from igneous (alkaline) suites and sedimentary (marine) rocks. India has a small exploitable phosphate reserve (Ca 200 million tonnes) mostly within the Proterozoic-Cambrian sedimentary rocks. These deposits occur in the basins lying in both the peninsular as well as the Himalayan parts of India. The use of Phosphate fertilizer in India has maintained a steady upward trend with an ever increasing demand of rock phosphate. India‘s production increased from 7000 tonnes in 1965 to 5,50,000 tonnes in 1980 yet leaving a requirement gap of more than one million tonnes of rock phosphate to be imported from other countries.

The exploration programme for sedimentary phosphorite in India gained impetus after the discoveries of deposits in Mussoorie and Birmania in Uttar Pradesh and Rajasthan respectively in the later half of of nineteen sixties.The largest phosphorite deposit of the country(64 mt reserve) was discovered at Jhamarkotra, situated 26 Km SSE of Udaipur in Rajasthan (Fig-1).

Phosphorite distribution

From the economic view point there is an uneven distribution of the phosphorite resources in the country. Bulk deposits lie in the southern part of Rajasthan and north – western corner of Madhya Pradesh within the ensemble of the Proterozoic Aravalli Supergroup. Jhamarkotra, Maton, Dakankotra, Kharbaria-ka-Gurha, Sallopat and Jhabua deposits in the Aravalli Supergroup together account for more than 80% phosphorite resources of the country. Perhaps the best documented belt in the Himalaya is the Mussoorie syncline which holds large resources of low grade ore (16-18% P_2O_5) .

Phosphorite deposits in the central part of peninsular India are located within the Bijawar Group (Upper Proterozoic) at Hirapur and Lalitpur in the States of M.P and U.P. respectively. In the southern part of the peninsula a very extensive and potential phosphorite deposit awaits detailed exploration in the Cuddapah basin of Andhra Pradesh [Fig-2 and Table 1].

Major Phosphogenetic Basins.

a) Aravalli basin of western India.
b) Bijawar basin of north-central India.
c) Cuddapah basin of southern India.
d) Krol-Tal basin of the Lesser Himalayas.

Minor Phosphogenetic Basins

a) Western India.
    1) Birmania
    2) Fatehgarh
    3) Jaisalmer
    4) Achrol
    5) Gandhra.
b) Southern India.
    1) Bhima
    2) Tiruchirapalli
c) Himalayan region

d) Other areas.
    1) Vindhyans
    2) Gondwana
    3) Meghalaya.

Table - I

APATITE / PHOSPHORITE LOCALITIES OF INDIA

(Index to Fig. 2)

1.	SITHARAMPUR AREA, Kasipatnam, Visakapatnam district, Andhra Pradesh (Apatite – magnetite – vermiculite veins, Precambrian age, 1.68 mt, 35 – 42 % P_2O_5)
2.	SRIKAKULAM district, Andhra Pradesh (apatite in veins)
3.	CHELIMA, Karnool district, Andhra Pradesh. (Phophatic quartizite, Cumbam formation, Cuddapah Supergroup, Precambrian).
4 & 5	PATHARGORA, NANDUP, KULAMARA, Singhbhum district, Bihar (Apatite – magnetite, Precambrian. 1.09 mt., 15.5 % P_2O_5)
6.	BHAWANATHPUR area, Palamau district, Bihar (Phosphatic horizon associated with calcareous shale, Precambrian. 87.8 mt, 5 – 7 % P_2O_5)
7.	HAZARIBAGH, Bihar (Apatite in mica bearing pegmatites).
8.	RANIGANJ, Bihar (Apatite in mica – peridotite dykes).
9.	GIRIDIH, Bihar (Apatite in mica – peridotite dykes).
10.	GOPPAR – GADHSISA, SADANBARI and JHURA areas, Kutch district, Gujarat. (Phospatic concentrations, Bhuj formation, Jurassic).
11.	AMBA DONGAR in Derbada valley, Gujarat (Apatite in carbonate body).
12.	NIGALIDHAR, KOARGAI and SOLAR areas, Solan, Sirmur and Shimla districts, Himachal Pradesh. (Phosphate horizon in association with chert and cherty carbonaceous shale; Krol and Tal groups, Jurassic, Palaeozoic and Eocene).
13.	UDHAMPUR, Kashmir. (Phosphate horizon in chert band within Sirban limestone and Muree group, Eocene).
14.	BARAMULA district, Kashmir, (Phosphate cherty shale and limestone, Palaeozoic).
15.	Near QUILON, Kerala offshore, (Monazite sand yields phosphate as by – product; Recent).
16.	LACCADIVE – AMINIDIVE ISLANDS. (Guano deposit, Recent. 0.09 mt, 13.11 % P_2O_5).

17.	JHABUA district, M.P. (Stromatilitic phosphorite, Precambrian, Aravalli Supergroup. 7.71 mt 15 – 29 % P2O5 , 31 mt 9 – 16 % P2O5).
18.	HIRAPUR, Sagar district, m.p. (Rock phosphate in Bijawar group, Precambrian. 18.66 mt of 23% P2O5. 22 mt of 5 – 10 % P2O5).
19.	GARO, KHASI, JAINTIA HILLS, Meghalaya, (Phosphatic nodules in shale of Kopili formation. Eocene).
20.	SUNG VALLEY, East Khasi hills district, Meghalaya. (Apatite in alkaline dltramafic carbonatite complex, 6.7 mt of 10 – 30 % P2O5 , 90 m.y).
21.	JHAMARKOTRA, MATON, KANPUR, Udaipur district, Rajasthan. (Phosphatic stromatolites, Precambrian, Aravalli Supergroup, 87.58 mt, 15 – 30 % P2O5).
22.	DAKAN KOTRA, KHARBARIA – KA – GURHA, Udaipur district, Rajasthan. (Phosphatic stromatolites, Precambrian, Aravalli Supergroup, 4.08 mt, 10- 25% P2O5).
23.	NEEHUCH MATA, SISARMA, PADAGAON, PERWAS, Udaipur district, Rajasthan. 63.70 mt 15 – 25 % P2O5). Precambrian, phosphatic stromatolites, Aravalli Supergroup.
24.	BHINDER, Udaipur district, Rajasthan. (Precambrian, phosphatic stromatolites, Aravalli Supergroup).
25.	NEWAHIA, Udaipur district, Rajasthan. (Apatite veins in carbonatite, Precambrian, 0.03 mt, 32 %).
26.	SALLORAT, Banewara district, Rajasthan. (Precambrian, phosphatic stromatolites, Aravalli Supergroup).
27.	RAM – KA – MUNNA, JHERMOTI, Banewara district, Rajasthan. (Precambrian, phosphatic stromatolites, Aravalli Supergroup).
28.	JODA, Chittorgarh district, Rajasthan. (Precambrian, phosphatic shale associated with Nimbahera shale of Lower Vindhyan).
29.	BIRMAHIA, Jaisalmer district, Rajasthan. (Precambrian, phosphatic shale limestone. 4.9 mt, 10 – 15 % P2O5).
30.	KATKAGARH, Jaisalmer district, Rajasthan. (Ferruginous phosphatic shale limestone, Hesozoic).

31.	DUNGARPUR, Rajasthan. (Apatite bearing schist, Precambrian).
32.	CHAPOLI, Jhunjhunu district, Rajasthan. (Precambrian, apatite associated with garnetiferous schist. 0.04 mt 15 % P2O5).
33.	ACHROL, Jaipur district, Rajasthan. (Precambrian, Delhi Supergroup; 1.80 mt 5 - 10 % P2O5).
34.	NAMBAKURUCHI VARAGUPADI area, Tiruchirapalli district, Tamil Nadu. (Upper Cretaceous, phosphatic nodules, 2 mt, 21 - 26% P2O5).
35.	SEVATHUR, North Arcot district, Tamil Nadu. (Apatite in carbonatite, Precambrian, 0.20 mt, 10 - 30% P2O5).
36.	MUSSOORIE area, Dehradun – Tehri – Garhwal districts, U.P. (Lower Palaeozoic, Lewer Tal Formation, 18 mt, 20% P2O5).
37.	LALITPUR, Uttar Pradesh. (Precambrian, Bijawar Group, 11.70 mt 12-25% P2O5).
38.	PITHORAGARH, Almora district, U.P. (Phosphatic stromatilites, Precambrian Gangolihat dolomite).
39.	KOTTAGUDIE area, Tamil Nadu. (Apatite – pegmatite, Precambrian).
40.	VALDAVUR, Tamil Nadu. (Phosphatic concretions and nodules, Upper Sreleceous).
41.	GUDDALORE, Tamil Nadu. (Phosphatic nodules).
42.	CHANNAPATNA, Karnataka. (Apatite in pockets).
43.	ARSIKERE, Karnataka. (Apatite in pockets).
44.	HOLE NARSIPUR, Karnataka. (Apatite in pockets).
45.	JAGADHRI, Tehri Garhwal, Uttar Pradesh.
46.	BELDIH, KUTNI, MEDNITANR, CHIRUGORA areas, Purulia district, W.B. (Precambrian, quartz-apatite-magnetite-quartz vein, 9.02 mt, 10-20% P2O5).
47.	HUNGENEKAL, Dharmapuri district, Tamil Nadu. (Apatite in carbonatite body, Precambrian, 0.05 mt., 36% P2O5).
48.	RIASI, Kashmir. (Phosphatic nodules).
49.	IB River, Gondwana basin, Orissa. (Nodular phosphorite in Lower Kamptee Sandstone and Barren Measures, P2O5 + 20 %).

Beneficiation of Rock Phosphate

Indian Bureau of Mines, has developed a method for beneficiation of low grade Phosphorite deposits and has carried out beneficiation studies of low grade phosphorite deposits, particularly samples from Madhya Pradesh. The results of 8 such samples are given below:

SALIENT DATA OF LOW GRADE ROCK PHOSPHATE INVESTIGATION

Sr No.	R.I. No.	Title of the Investigation	Original Analysis %		Mineralogy	CONCENTRATE				Process Adopted
						Wt%	Assay %		Rec.%	
1.	920	Beneficiation of a low grade **Rock Phosphate** (Overburden) Sample from Khatamba and Kelkua Mines, Jhabua dist., M.P. for M/s M.P. State Mining Corporastion Ltd.	P_2O_5 MgO CaO SiO_2 Fe_2O_3 Al_2O_3 TiO_2 LOI	12.58 0.53 20.08 51.60 4.18 3.85 0.23 5.53	**Val. Minerals**: Apatite **Gangue :** Calcite, Quartz, Clay, Chlorite, Iron Oxides, Amphiboles Garnet	34.00	P_2O_5 MgO CaO SiO_2 Fe_2O_3 Al_2O_3	31.50 0.38 49.09 10.03 1.44 0.74	85.30	Flotation
2.	940	Beneficiation of a very low grade calcareous **Rock Phosphate** Sample from	P_2O_5 MgO CaO	8.50 0.56 32.69	**Val. Minerals**: Apatite **Gangue :**	22.10	P_2O_5 CaO SiO_2	25.86 46.92 9.73	63.70	Flotation

		Kelkua – Nala, Jhabua dist., M.P. for M/s M.P. State Mining Corporastion Ltd., Bhopal	SiO_2 Fe_2O_3 LOI	29.08 1.59 19.91	Calcite, Quartz, Iron Oxides					
3.	960	Beneficiation of a low grade calcareous **Rock Phosphate** sample from Amliamal Block, Jhabua area, Jhabua dist., M.P. for M/s M.P. State Mining Corporastion Ltd., Bhopal.	P_2O_5 MgO CaO SiO_2 Fe_2O_3 Al_2O_3 LOI	12.75 0.50 36.75 20.07 1.34 2.61 17.90	**Val. Minerals**: Apatite **Gangue :** Quartz,Clay, Iron Oxides, Calcite, Mica, Amphibole	39.70	P_2O_5 CaO SiO_2	28.32 46.37 6.92	82.90	Flotation
4.	971	Beneficiation of a low grade siliceous **Rock Phosphate** Sample (Mine Rejects) from Hirapur, Sagar distt., M.P. (in collaboration with RRL, Bhopal).	P_2O_5 MgO CaO SiO_2 Fe_2O_3 Al_2O_3 TiO_2 LOI	12.09 0.61 15.45 52.26 5.90 7.20 0.47 1.91	**Val. Minerals**: Apatite **Gangue :** Quartz, Clay, Cacabonates, Rutile, Iron Oxides,	26.20	P_2O_5 CaO SiO_2	35.06 45.43 9.54	75.20	Flotation
5.	972	Beneficiation of very low	P_2O_5	12.53	**Val. Minerals**:	31.20	P_2O_5	28.10	69.60	Flotation

		grade calcareous **Rock Phosphate** sample (Rejects) from Kelkua-Nala and Amliamal Block, Jhabua dist., M.P. for (in collaboration with RRI, Bhopal).	MgO CaO SiO_2 Fe_2O_3 Al_2O_3 TiO_2 LOI	0.60 31.95 26.43 1.59 6.05 0.13 19.11	Apatite **Gangue :** Quartz,Clay, Iron Oxides, Calcite, Rutile, Mica,		MgO SiO_2 CaO	0.19 6.24 49.10		
6.	976	Beneficiation of a Dolomitic **Rock Phosphate** sample from Khatamba Block, Jhabua dist., M.P. for Mineral Exploration Corporastion Ltd., Nagpur.	P_2O_5 MgO CaO SiO_2 Fe_2O_3 Al_2O_3 LOI	11.40 11.75 33.77 13.10 0.73 0.45 28.13	**Val. Minerals**: Apatite **Gangue :** Dolomite, Quartz, Calcite, Iron Oxides,	29.20	P_2O_5 MgO SiO_2 CaO	31.05 2.75 6.95 47.70	79.90	Flotation
7.	1029	Beneficiation of very low grade dolomite **Rock Phosphate** sample from Rupakheda Block, Jhabua dist., M.P. for (Mineral Exploration Corporastion	P_2O_5 MgO CaO SiO_2 Fe_2O_3 Al_2O_3	5.85 13.28 28.19 15.52 0.90 0.82	**Val. Minerals**: Apatite **Gangue :** Dolomite, Calcite, Quartz, Iron Oxides,	9.60	P_2O_5 MgO SiO_2	26.73 2.37 16.85	46.10	Flotation

		Ltd., Nagpur) for Director, Regional Resarch Laboratory, Bhopal	TiO_2 LOI	0.03 32.86	Mica, Amphibole					
8.	1144	Pilot Scale beneficiation studies on a low grade siliceous **Rock Phosphate** sample from Hirapur, Sagar dist., M.P	P_2O_5 MgO CaO SiO_2 Fe_2O_3 Al_2O_3 TiO_2 LOI	12.16 0.50 15.65 53.81 5.58 7.59 0.36 1.53	**Val. Minerals**: Fluorapatite **Gangue :** Quartz, Iron Oxides, Mica,	27.40	P_2O_5 CaO Fe_2O_3 SiO_2 Al_2O_3 MgO LOI	32.40 42.00 2.80 15.50 4.50 0.70 0.65	72.80	Flotation

POTASH

The term potash, originally referred to only potassium carbonate, which was derived from the ancient practice of evaporating, in iron pots, the solutions leached from wood ashes. Among the various evaporate minerals, potash minerals along with their K2O content (British Sulphur Corp., 1979; Johnstone et al., 1961; Read, 1960; Deeson, 1973) are tabulated in Table – 1.

The potassium element is important not only to plants, but also fulfills the vital functions in human and animals. Amongst the potassium compounds, potassium chloride, potassium sulphate and the double salts of potassium (potassium – magnesium sulphate) have been found to be effective for use in potassium fertilizers.

TABLE -1 : List of evaporate minerals along with their K_2O %

Name	Composition	% K_2O
	Non – Potassic Minerals	-
Anhydrite	CaSO4	-
Bischofite	MgCl26H2O	-
Borax	Na2B4O710H2O	-
Epsomite	MgSO47 H2O	-
Gayluosite	Na2CO3CaCO35 H2O	-
Gypsum	CaSO4 2 H2O	-
Halite	NaCl	-
Kieserite	MgSO4 H2O	-
Nahcolite	NaHCO3	-
Pirssonite	Na2CO3CaCO32 H2O	-
Tachyhydrite	2 MgCl2 CaCl212 H2O	-
Trona	NaCO3. NaHCO32 H2O	-
	Potassic Minerals	
Carnallite	KCl.MgCl26 H2O	17
Glaserite	Na2SO4. 3K2SO4	43
Hanksite	9 Na2SO4. 2Na2. CO3 KCl	3

Kainite	4 (KCL. MgSO4). 11 H2O	19
Langbeinite	K2 SO4 Mg SO4	23
Nitre / Chile Salt Petre	KNO3	47
Polyhalite	K2 SO4 Mg SO4 2CaSO42 H2O	16
Potash Alum	K2 SO4 Al2(SO4)3 24 H2O	10
Rinneite	3 KCl.NaCl.FeCl3	32
Schoenite	K2 SO4 Mg SO4 6 H2O	24
Sylvie	KCl	63
Syngenite	K2 SO4. $CaSO_4$ H2O	29 % K2O

In spite of a uses of its application to the agricultural and orchard crops, potassium fertilizer has not received importance equal to that of phosphate and nitrogen fertilizers, probably due to cost factor and localized production of the potash salts.

Sources of Potash

Presently, the major production of potash, in the world, comes from potash-bearing marine evaporate deposits.

Evaporite Deposits

Sediments resulting from evaporation of marine and nonmarine waters form the evaporate deposits. Most of the important deposits of potash, all over the world, are hosted in the marine evaporates. These are mostly derived from seawater, but under special conditions lakes may also give rise to bodies of borate minerals, sodium carbonate minerals, and other similar types.

Potassiferous Evaporite Deposits in India

The occurrence of marine potash-bearing evaporate sequence is recorded from the northern and northwestern parts of Rajasthan and the adjoining states of Haryana and Punjab, Ramchandra et al (1985) and Dey (1991).

West of the Aravalli Mountain range, a sequence of late Neo-Proterozoic, unmetamorphosed, marine, sedimentary sequence is exposed in the Nagaur-Ganganagar Basin, previously referred to as the Nagaur basin (Roy Chowdhary et al., 1965). The sequence was informally recognised as Trans-Aravalli Vindhyans (Heron, 1932), in view of its close similarity with the Vindhyan rocks exposed in eastern Rajasthan and MP together with evidences of the

presence of soft-bodied animals (tracks, trails etc) of the terminal Proterozoic period. This sequence was named as the Marwar Supergroup (MSG) by Khan and Sogani (1973). The MSG rocks show gentle dips (2° to 5°) towards N and NW, and are overlain by thick Mesozoic-Tertiary-Quaternary sediment cover. North of Nagaur, halite-bearing thick evaporate sequence of Hanseran Evaporite Group (HEG) has been intersected in boreholes drilled by Geological Survey of India (72 for potash, 45 for gypsum, 50 for lignite), ESSAR Oil, Oil India ltd, Oil and Natural Gas Corporation, Central Ground Water Board and State Ground Water Board. Based on long-range, inter-basinal and intrabasinal correlation, the rocks of the MSG are assigned Late Neo-Proterozoic to Early Cambrian age, while Eocambrian (Vendian) age has been assigned to the rocks of the HEG and to its time equivalent, lateral facies variant rocks of the Bilara Group and the Birmania Formation (Virendra Kumar, 1991) exposed in the southern and southwestern parts of the basin, respectively.

Reserve and grade of potash salts in various sub-basins of Nagaur-Ganganagar basin, Rajasthan.

Sub – basin/ Basin	**Area (km^2)**	**Ore Reserves (Million tonnes)**		**Grade K %**
		Probable	**Possible**	
Satipura	245.61	202.30	1429.95	4.80
Bharusari	71.00	88.16	300.15	4.68
Lakhasar	29.50	113.73	342.29	4.39
Total	346.11	404.19	2072.39	4.70% Av

Source : Virendra Kumar, 1999a and 1999b

Reserves and Grade

The following reserves at 3% K grade, have been estimated for a minimum stopping width of 1.5 m in different sub – basins.

Three halite cycles (H2, H6 and H2) with evidences of potash mineralization were intersected in a solitary borehole in the Jaitpura sub-basin (275 km^2 area). This sub-basin seems to be promising.

The total reserves (probable and possible) of 2476 Mt averaging 4.70 % K or about 5% K2O in the three sub-basins are on the conservative side (Virendra Kumar et al., 1992 and Virendra Kumar, 1996a and 1999).

In addition, 6 trillion tonnes of halite with over 80% NaCl have also been estimated in parts of the Nagaur-Ganganagar basin occurring north of the sulphate predominant transitional area [Dasgupta, et al., (1986) and Virendra Kumar et al., (1996a, 1996b, 1998)].

LACUSTRINE, SEA WATER, BRINES / BITTERN AND OTHER RESOURCE OF POTASH IN INDIA

Lacustrine

Tso-Kar Lake (Leh) in Jammu and Kashmir located about 160 km from Leh in the Rupshu area is the only known lacustrine source of potash in India.

Extremely constrited, the present Tso-Kar Lake is very shallow, occupying approx, an area of 12.5 km^2. It represents the remanent of an original lake, covering about 136 km^2, with 66 m thick associated lacustrine deposits (Rastogi, 1979). The total volume reduction of the lake is estimated to the order of 2000 times (TIFAC, 1999). It is an extremely saline lake with lacustrine deposits (having salt efflorescence) covering a wide area around it.

The precipitated evaporate layer occur very close to the inlet zone and have 10.2 to 24.6 % Ca.

Inaccessible geographical location and the availability of small quantity of potassiferous brine render the Tso-Kar Lake potash resources uneconomical.

Sea Water Brines and Bitterns in India

Sea water is the major source of potassium. Blessed with a seacoast of about 7500 line km. India has an inexhaustible source of potassium salts. Large quantities of sub-soil concentrated brine are available at many places along the coast. After recovery of common salt, the salt pan bittern when evaporated give rise to mixed salt with high (18-20%) potassium chloride along with many other chemicals of economic importance. However, the bitterns obtained in the evaporating pans from sub-surface brine or sea water could not be economically

exploited for recovery of potassium salt. The different processes worked out to extract potash directly from sea water, so far, have been found uneconomical.

It has been established by CSMCRI that for every 100 tonnes of common salt production, 2.75 tonnes of potassium schoenite can be recovered from the bittern (Patel and Talati, 1984, Bokil et al., 1984, Kachhara, 1984). In addition 0.8 tonnes of sodium sulphate, 0.18 tonnes of bromine, 4 tonnes of magnesium chloride and 2.9 tonnes of magnesium sulphate can also be extracted.

Resources of Sea Brine and Bittern

India, with enormous area of sub-soil marine brine along its coastal track, has inexhaustible resource of sea brine. At present with annual production of 10 Mt of common salt (out of total 14.5 Mt of common salt production). India has a renewable sea bittern resource of 9440 x 10^6 litres per year from which 0.27 Mt. of potassium schoenite containing 18-20% KCl could potentially be recovered annually.

Recovery of Potash from sea brine / sub-soil brine/bitterns

The recovery of common salt as NaCl from seawater has been practiced from time immemorial, in many parts of the world under widely varying conditions. However, the recovery of associated chemicals, mainly, salts of K, Mg and Br was possible only in the early 20^{th} century. Today, seawater accounts for major salt production in the world, and is quite significant for magnesium metal, magnesium compounds and bromine, while it is also a vital source of potassium salts. The present trend is towards greater dependence on seawater (as a source) due to environmental reasons and its inexhaustible resources.

The recovery of valuable chemicals from seawater bittern has been extensively investigated. The phase chemistry of seawater bittern is exceedingly complex, since the equilibrium and metastable transformation occur and predominate in the system. Only in the recent past it has been possible to develop commercially viable routes to separate many of the chemicals from the bitterns. Several processing methods for the recovery of by-products from bitterns have been suggested. These processes generally aim at recovery of various forms of potassium, magnesium, sodium and bromine.

The basic principle is that after harvesting common salt from mother liquor at 29^o to 30^o Be' density, the residual brine (bittern) contains other salts in concentrated form which on

further solar evaporations, at graded intervals, yields, different solid fractions. The 1st solid fraction obtained between 29° and 34° Be' density is called crude salt which is (mainly) common salt with minor amounts of other salts. The 2nd solid fraction obtained between 34° and 36° Be' contains a mixture of NaCl and $MgSO_4$ known as Sel's mixture, which is used mainly for recovery of sodium sulphate. The 3rd solid fraction collected between 36° and 38° Be' is mixed salt (containing 18-20% KCl; 15-18% NaCl; 32-35% $MgSO_4$ and 6-7% $MgCl_2$) useful for the recovery of potassium chloride, potassium syngenite (K2 SO4 CaSO4 H2O); Potassium Schoenite (K2 SO4 Mg SO4 6 H2O) magnesium sulphate; sodium sulphate etc.

Discussion

The technology developed by CSMCRI, though successful at Pilot plant level, needs to be completely established by conducting field-level trials and demonstrating its effectiveness in co-ordination with salt manufacturing units and also the potash fertilizer industry.

For recovery of potassium chloride from Carnallite, Cold Crystallisation Process has been developed to save on energy input. This technique is being used both by Arab Potash Ltd. and Dead Sea Works Ltd. and can also be used in India.

Field experiments have shown availability of bittern with higher concentration of Potassium salts, formed naturally, at Khavda and Ganga Bet in Great Rann of Kachchh. These are two prospective areas for immediate Potash recovery in India. Similarly sub-soil brine in Kharaghoda area with lower concentration of magnesium salt also need to be fully exploited for recovery of carnallite-type of mixed salt and potassium chloride from it.

Glauconite Occurrences in India

Glauconite is found commonly associated with sand / sandstone, shale, marl and occasionally with limestone in the rock formations ranging in age from Precambrian (Bhima sediments of Karnataka and Andhra Pradesh; Vindhyans of U.P., M.P., Rajasthan and Bihar) through Cretaceous and Eocene (Ladakh, Garhwal, Rajasthan and Assam) to Recent off-shore sediments off the Trivandrum coast, Bay of Bengal and coasts of Andaman Nicobar Island .

The glauconite deposits of U.P., M.P., Rajasthan, Gujarat, A.P. and Karnataka are well developed and have been studied in detail. The glauconite occurrence from other stratigraphic horizons are only of academic significance. Estimated resources of glauconitic sandstone is about 3000 Mt, in the country.

Glauconitic Sandstone Formation of the Lowest Vindhyans (1045 + 40 million years) (Vinogradow et al, 1964; Homes, 1964) represents the oldest glauconite-bearing horizon in the world. The glauconite deposits are well developed in the central parts of the Son Valley covering parts of Madhya Pradesh, Uttar Pradesh and Bihar. Besides, glauconitic shales belonging to Semri Series of Vindhyan Supergroup are developed in Chittorgarh, Kota and Karauli areas of Rajasthan (DGM, 1999). The Vindhyan glauconite sandstone at places contains minor P_2O_5 to the order of 0.31% (Mehrotra and Bhattacharya 1975).

Status of R & D Work in India

Keeping in view the consumption of potash fertilizers in India, non-availability of any commercial source of potash in the country, and ever increasing import bill, several organizations / institutions are engaged in R and D work to find use of glauconite as an alternative source of potash.

GEOLOCIAL SURVEY OF INDIA

1. GSI conducted preliminary tests for water solubility on glauconitic sandstone for extraction of water soluble potash.

2. GSI has established that glauconitic sandstones from selected area of Banda district, (U.P.) yield up to 3 to 7% water soluble K2O (Khan, 1986). Acid leachability tests on glauconitic sandstone have also been conducted.

3. A process of extracting KCl crystals from K2 SO4 solution has been effectively developed, on laboratory scale, by Virendra Kumar and Singh (1998).

   i) Potassium sulphate (K2 SO4) was obtained in aqueous condition at normal temperature and pressure conditions. It was mixed with aqueous Ca Cl_2 (selected for economical considerations) and the mixture (of K2 SO4 and $CaCl_2$) was left for about a month (to provide sufficient time for gypsum to precipitate and to bring KCl in solution) to complete the following reaction $K_2 SO_4 + CaCl_2 + H_2O$ ® $KCl + CaSO_4.2H_2O + H_2O$

ii) Gypsum ($CaSO_4$ $2H_2O$) was separated by filter-ation through Whatman No.40 filter paper (no washing was given) to ensure that even traces of gypsum may not contaminate the filtrate.

iii) The precipitate, dried at room temperature, contained (X-ray defraction analyses showed) the presence of only two major mineral phases in the precipitate namely, anhydrite ($CaSO_4$) and Bassanite ($2CaSO_4.H_2O$).

iv) 50 ml of filtrate was evaporated by flame heating to yield a mixed – salt containing gypsum ($CaSO_4.2H_2O$); Syngenite (K_2 SO_4 $CaSO_4.H_2O$) Hexahydrite ($MgSO_4.6H_2O$) and Picromerite (K_2 SO_4 $.6.H_2O$).

Further experiments were conducted to reduce and optimize the reaction time.

1. The use of $CaCl_2$ (50%) solution as a precipitating reagent extracted 94.5% of the total sulphate present in the K2 SO4 solution.

2. The use of ethyl alcohol as catalytic agent alongwith $CaCl_2$ (50%) solution helped reduce the time with increased recovery (99.0%) of the total sulphate. The ethyl alcohol used can be recovered (by distillation) and recycled.

3. Use of glycerol, isobutyl alcohol and saturated NaCl solutions did not yield better results.

Though, the results of above experiments have a direct bearing for recovering potash in useable form from glauconitic sandstones, containing 3 to 7 % water soluble K2O , yet the economics of such recoveries have to be evaluated in the light of easy availability of highly soluble potash salts of marine origin in the international market, against non-availability of it in India.

CENTRAL MARINE CHEMICAL AND SALT RESEARCH INSTITUTE (CSMCRI), BHAVNAGAR, GUJARAT

Intensive R & D work at laboratory scale as well as on pilot plant scale has been carried out at CSMCRI (1980) for recovery of potash salts from bittern.

REGIONAL RESEARCH LABORATORY (RRL), BHOPAL, M.P.

The RRL, Bhopal also took up R & D work (on the request of GSI) on laboratory scale for extraction of potash from glauconite through several approaches.

RRL Bhopal has developed two types of fertilizers, viz (1) in solution form by leaching potassium salts from glauconite, and (2) in solid form by leaching of glauconite concentrate using sulphuric acid as medium and phosphorite as additive mineral.

REGIONAL RESEARCH LABORATORY (RRL), BHUBNESHWAR

1. The RRL has developed process for recovery of fertilizer grade "Double Salt" from bittern.
2. The process was tested on laboratory scale using 50-100 kg of bittern.
3. Minimum economic size of the plant based on the process developed is 20 tonnes per annum and the recommended size for commercial plant is 40 tonne per annum.
4. Laboratory results have shown a yield of 40% per tonne of bittern and Power consumption of 0.22KW / tonne of produce. Estimated production cost is Rs.400/ tonne against likely price realization of Rs.1800/ tonne for the Mixed salt.
5. While the preliminary data based on laboratory scale experimentation is encouraging, RRL is looking for a suitable participant from private or Government sector to finance its' pilot plant trials.
6. The plant and equipment for putting up a plant based on this process is available indigenously and no imported input is required for process instrumentation and control, spares and consumables etc.
7. No special skills of manpower are required. Thus, the plant can be put up entirely with local inputs.
8. Further improvements planned in the process may yield refractory grade Magnesia and other Potassium Chemicals also.

AGRICULTURAL UNIVERSITIES

The Department of Agronomy, Banaras Hindu University, Varanasi, (U.P.); Bidhan Chandra Krishi Viswavidyalaya, Nadia, (West Bengal); and Gujarat Agricultural University, Navasari, (Gujarat) carried out studies on glauconite-bearing shale samples, containing 3 to 4% water soluble potash, from Newari and Patwadh areas of Uttar Pradesh for their utility and uptake studies as a direct slow-acting potash fertilizer over wheat and paddy crops:

The results based on field experiments on applicability of glauconite as potash fertilizer, are quite encouraging.

GUJARAT AGRICULTURE UNIVERSITY, NAVASARI GUJARAT

The experiments conducted by the University, on glauconite sandstone/shale samples from Guneri area, (Kachchh district) on the local soils, revealed the followings :

1. The local soils of Gujarat derived from the weathering of Deccan traps are highly alkaline (pH 7.2 to as high as 8.0).
2. In such highly alkaline soils there is no deficiency of potash. Even the response of many crops to K-fertilisation with muriate of potash (containing 60% water soluble K_2O) are not observed in these soils of Gujarat.

The Guneri glauconite sample from Gujarat, contained only 3.8%K (i.e. 4.56% K_2O). The K2 O from the glauconite sample supplied was soluble in very strong acid mixture (HCF – $HClO_4$). Under these circumstances glauconite sandstone / shale cannot be used as source of potash or soil conditioner in Gujarat soils.

CONCLUSION

The categorization of 'Potash' into **scarce commodity** in India is not for the lack of potash resources in the country but is basically due to non-production of potash salts from various indigenous sources of potash for one or more of the following reasons for achieving self sufficiency in potash fertilizers in the country due attention should be paid to optimally utilize the available indigenous resources of potash.

1) Non-availability of techno-economically exploitable marine potash deposits is a constraint. The only known marine evaporate sequence in India is present in Nagaur-Ganganagar basin (Rajasthan) in which more than 24,000 Mt of potash deposits with 5% K2 O has been estimated to occur at depth below 600 m from the surface. Efforts are to be made, through exploration to locate commercially viable marine potash deposits at shallower depth in Nagaur-Ganganagar basin, Rajasthan particularly in parts of Jaitpura sub-basin.
2) Non-extraction of potash salts from the sea brine sub-soil brines and bittern of salt pans in coastal parts of the country (coastal Gujarat, Maharashtra, Tamil Nadu and Andhra Pradesh in descending order of potash potential area)

3) Lack of awareness of extracting potash salts from the waste products of Thermal Power Plants (fly ash/flue gases of cement industry, alcohol industry based on fermentation process of molasses, which are being allowed to go as waste.
4) Non-utilisation of huge greensand (glauconite sandstone) deposits in the country.
5) R & D efforts are to be made to develop techno- economically feasible and eco-friendly technology for extraction of potash salts from identified industrial wastes.

GYPSUM

Gypsum is a hydrated calcium sulphate and occurs as selenite, alabaster and satinspar, while anhydrite is simply-calcium sulphate. Gypsum and anhydrite occur as massive compact beds within evaporates. However, gypsite which contributes mostly towards the production of gypsum, is an earthy gypsum of inferior quality invariably mixed with sandy clay and calcareous matter. Gypsite occurs under a cover of aeolian and/or alluvial sand/clay sequence in low lying areas and old river courses.

About 94% of the total Indian production of mineral gypsum comes from Rajasthan and 5% from Tamil Nadu. The rest of the production is derived from the states of Gujarat, Himachal Pradesh, Jammu & Kashmir and Uttar Pradesh. Out of the proven reserves of 1272 m. tonnes of gypsum resources in the country, Rajasthan State singularly contributes the lion share of 1028 million tonnes of which 1013 million tonnes have been investigated and estimated by Geological Survey of India.

In addition to mineral gypsum, sea water and phosphoric acid plants form important sources of by-product gypsum. Chemical plants manufacturing hydrofluoric acid and refining borax are the other sources of by-product gypsum.

Enormous reserves of anhydrite are hosted within the evaporates of the Hanseran Evaporite Group sub-cropping over an area of about 100,000 sq km between depths of 270 m and 1200 m in Nagaur, Bikaner, Churu, Hanumangarh and Ganganagar districts of Rajasthan, Bhatinda and Faridkot district of Punjab and Sirsa district of Haryana. Gypsum is chiefly used in the manufacture of cement, chemical fertilizers, plaster of paris, and distemper. It is also used for soil conditioning in agriculture. Another important use of gypsum is in paper industry and as filler in insecticides. Selenite, the crystalline variety of gypsum, is used for making gypsum plates in microscopes

RAJASTHAN

In Rajasthan, deposits of gypsum occur mainly in bikaner, Nagaur, Barmer, Jaisalmer, Churum Hanumangarh and Sriganganagar districts. Although the most important deposits are located in Nagaur district, Bikaner and Hanumangarh districts are the leading ones in production of gypsum. In addition to this, minor occurrences have been reported from Pali and Bharatpur districts also.

Based on the mode of occurrence, there are two types of gypsum deposits viz.

a) Surficial evaporate segregations of massive gypsite of Quaternary age occurring below a thin overburden (1-3m) of aeolian and/or alluvial cover, which are presently being mined for the past many decades for various purposes and supplied to different industries all over the country, and
b) Beds and seams of gypsum associated with limestone and argillaceous strata of the Hanseran Evaporite Group (Eocambrian age) belonging to the Marwar Supergroup (Fig-2) (late Proterozoic to Early Cambrian) (previously grouped under Nagaur Series/Formation of Trans-Aravalli Vindhyan); occurring at depths of 30 to 115m and more representing the oldest known evaporate sequence in India and probably in the world also.

Surficial Deposits: About 90% of the total Indian production of gypsum comes from northwestern and northern parts of Rajasthan. Here gypsum occurs as massive, granular platy or fibrous aggregates mixed with sand, clay and calcareous matter under cover of sand in low lying areas, interdunal areas and along old river courses. The bulk of gypsum/gypsite produced is from Nagaur, Bikaner, Ganganagar, Hanumangarh, Churu, Jaisalmar and Barmer districts and is of 80 to 85% purity. Quaternary sediments of varying thickness covers most parts of the area.

TAMIL NADU

Gypsum is distributed over 57 sq km area from Trappay in the south and Periakurukkai and the SW to Chittali and Asur in the north in Tiruchirapalli district. Compact gypsum occurs in Uttatur stage of Cretaceous strata between Namba-Kurichi, Garudamangalum, Srikanbur and Karai in Tiruchirapalli district. Here it is intimately associated with clayey material and constitute only 5% by volume.

In Coimbatore district, it occurs as nodules in black soil tracts south of Palladam and in the form of concretions and nodules in soil in Kokkadi, Avattundal and Kilakunai and Ramanathpuram and Tirunelveli districts. Impure gypsum mixed with Kankur occurs in thin layers in Tirunelveli district. Selenite is found in clayey beds near Ennur, Mongur, Choultry and Kathiwakam in Chinglepet district.

Tamil Nadu contributed 5% of the total production of gypsum in the country. Various deposits of gypsum were prospected by G.S.I. in different districts of the state.

In Tamil Nadu Gypsum occurs in two forms – one is of Marine Origin and the other is of Alluvial form. The **Marine Gypsum** is found to occur in bad land topography area of parts of Tiruchirapalli and Perambalur Districts. The type areas for Marine Gypsum are Odiyam, Maruvathur, Karai, Therani, Uttathur, Nambakurichi, Peruvalapur, Garudamangalam, Kolakanatham and Tappay near Pullampadi.

Gypsum occurs in an extent of 46 Sq. Kms. In the above area and in Odiyam area about 1,600 acres are covered under soil. It is estimated that the total soil cover in the Gypsum bearing area is nearly 7,300 acres.

There are 4 varieties of Gypsum occurring in the above area viz. (1) Selinite (Transparent crystals) (2) Fibrous variety (3) Platy variety and (4) Fine disseminations is clays. According to Krishnan, the probable reserves of Gypsum in the above area are estimated about 15.3 million tones to a depth of 13 metres.

In Tamil Nadu **Alluvial Gypsum** occurs as nodules and segregation of crystals in the black clays of Palladam Taluk of Coimbatore District. The depth persistence is about 2 meters and the concentration of Gypsum is around 8%. The important Alluvial Gypsum bearing areas are Gomangalampudur, Periapudur, Palladam, Jottampatti, Vidampatti, Adivalli and Ariyur. Geological Survey of India has estimated the reserves of Gypsum in the above area as 56,000 metric tones.

Small occurrences of Gypsum are noticed in parts of Mudukulathur Taluk of Sivagangal District and also in parts of Tirunelveli District. Futher, number of Salt Pans are all along the coast of Tamil Nadu. **Salt Pan Gypsum** (Selenite) is formed during the crystallization of Common Salt from the sea water. Though the reserves has been estimated about 50,000 metric tones, this may vary on par with the extent to be used for the manufacturing of Common Salt.

From the above, it is observed that the reserves of Gypsum in various forms in the State of Tamil Nadu are comparatively larger one. Though certain percentage of Gypsum of all kinds

are being used in Cement Industries and also in Plaster of Paris manufacturing Industries, large quantity of Gypsum is left behind. In this regard, it is suggested that a detailed study to ascertain the higher quality of Gypsum of all varieties available in the above areas and their feasibility to establish a

" Pilot Sulphuric Acid Plant " may be taken up in order to establish a **new Sulphuric Acid Plant** from the uncared and unexploited Gypsum deposits available in the State of Tamil Nadu.

JAMMU AND KASHMIR

In Jammu and Kashmir number of gypsum occurrences has been recorded and gypsum is being produced from different districts.

Baramula district:

Massive, compact and fine grained gypsum occurs in Ijara ($34^{o}10'30"$: $74^{o}13'30"$)-Islamabad-Dhanni Saiyidam ($34^{o}06'20$: $74^{o}04'45"$) belt in Uri tehsil of Baramulla district. The deposit is associated with graphitie phyllites and schists of Salkhala Formation (Precambrian). The deposit occurs over a 24km long tract, north of Jhelum Valley near Bambyar village, occurring as replacements in dolomite and limestone. The deposits have been investigated in details.

The total reserves of gypsum of all grades in Baramulla district are estimated at 63.82 million tonnes, out of which reserves of 5.76 million tonnes have already been proved.

Occurrences of Gypsum deposits have been reported from UttarPradesh, MadhyaPradesh, HimachalPradesh and Gujarat.

CHAPTER- VI

STRATEGIC POLICY

Intensification of nonmetallic industrial mineral and fertilizer mineral exploration activity has been made as top priority agenda by the policy makers at the highest level of the Government owing to the spiraling demand of the commodity by the primary mineral industrial sector since last decade. In this backdrop, the importance of both long and short term policies in the realm of exploration as well as co-ordination among the entire concerned National and State Exploration Agencies and also private entrepreneurs have increased many fold.

Short term policy

(1) Collation of existing database and subsequent selection of blocks have to be made for concentrating sub-surface exploration.

(2) Multi-organizational concerted efforts are necessary for upgrading the confidence level of the resources followed by mine feasibility study. In essence, there has to be a synergistic approach between regional and detailed exploration.

(3) Low altitude aero-geophysical multisensor surveys both by fixed wing and heliborne over large expanse of potential terrain.

(4) Deep drilling of potential targets for identification and confirmation of the concealed ore body

Long term policy

Synthesis of available geological database reveals that in future the possibility of substantial accretion of shallow level resources with quarriable prospect is really meager. In this backdrop a strategic shift has to be made by introducing geo-statistical analyses for prognostication of potential areas as well as multidisciplinary approach (basin modeling, geophysical survey, remote sensing techniques etc) for concept oriented search in accordance with the current global models, along the following lines.

(1) Geo-statistical analyses of available database to prognosticate the potential areas (both spatially and vertically) in all needed reserves as a prelude for formulation of exploration programme.

(2) Multi-parametric geophysical surveys and remote sensing studies, particularly in covered terrains, to delineate areas for future exploration.

(3) In the light of the state of the art knowledge base, generation of relevant data set (chemical, petrological, geotechnical etc.), required in course of regional exploration to examine the possibility of new findings for alternate and optimal utilization of the resource.

(4) To frame exploration strategy for minerals having poor resource cum reserve base in locales of favourable geological milieu.

(5) Development of innovative technologies for the assessment of quality and processing properties and for the production and processing of raw materials

(6) Geological and economic evaluation of prospects and regions. To re-orient the organizational methodology to undertake collaborative venture with private entrepreneurs.

(7) To devise a multidisciplinary concept oriented programme of regional exploration by GSI (nodal agency for regional exploration) in association with all National and State exploration agencies .

(8) High precision laboratory studies with induction of state-of-the art equipment.

XII - PLAN FIELD ITEMS – G.S.I. REGIONS

CENTRAL REGION

FIELD SEASON 2012 - 2013

Sr No	Commodity	Operations	Title	Activity Code Geological Axis
1.	Graphite	Chhattisgarh OP; MPCG Raipur	Preliminary investigation for graphite in Raipur nala (T.S. No. 64 N / 9) and Ib river, west of Allori village (T.S. No. 64 N / 13), Jashpur district (G – 4) **Personnel : 2G**	G 4
2.	Barite	Maharashtra OP: Mah. Nagpur	Preliminary investigation for barite in the Naleswar – Tukum area, Chandrapur district, Maharashtra. (T.S. No. 56 M / 9 & 56P /12) (G – 4) **Personnel : 2G**	G 3
3.	Phosphorite	Madhya Pradesh OP : MPCG, Bhopal	Preliminary investigation for Phosphorite deposit in Kachaldara – Kalikhet – Nawapara area, Meghnagar Tehsil, Jhabua district, M. P. (T.S. No. 46 J / 5).	G 3

2013 - 2014

4.	Graphite	Chhattisgarh OP; MPCG Raipur	Preliminary investigation for graphite in Raipur nala (T.S. No. 64 N / 9) and Ib river, west of Allori village (T.S. No. 64 N / 13), Jashpur district . **Personnel : 2G**	G 3

2016 - 2017

5.	Kyanite	Maharashtra OP: Mah. Nagpur	Assessment of kyanite in Dahegaon–Pipalgaon Extension areas, Sakoli Fold belt, Bhandara district, Maharashtra. (T.S. Nos. 55 P / 13, 14) **Personnel : 4G**	G 3

WESTERN REGION

PERIOD 2012 - 2017

Title :	Search of low silica SMS grade limestone in Western Rajasthan
Objective :	To locate low-silica SMS (LD – grade) limestone as per increasing demand by steel plants
UNFC stage :	G – 3
Geologist :	2 G (5 years)

PERIOD 2014 - 2017

Title :	Search of limestone suitable for Chemical, SMS and other grades in Vasai-Makanpur and Gorinja areas in Okha Mandal, Jamnagar district, Saurashtra, Gujarat.
Objective :	To locate Chemical, SMS and other grades limestone
UNFC stage :	G – 4
Geologist :	2 G (3 years)

OPN: GUJARAT

PERIOD 2012 - 2017

Title :	Search for titanium and REE in the bench sand from Dumas to Tithal coast of Surat and Valsad districts Gujarat.
Objective :	To assess the potential of beach sands for potential of titanium resources.
UNFC Stage :	G – 4
Geologist :	2 G (5 Years)

NORTHERN REGION

FS : 2012 – 17

Title : To locate new gypsum occurrences, find their lateral extension in covered areas as well as find their depth persistence in parts of Hissar and Bhiwani districts, Haryana.

Personnel : 2G

Nature and quantum of work

Nature of work	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
LSM (1 : 12500)	60 sq km	60 sq km	60 sq km	60 sq km	60 sq km
DM (1 : 2000)	0.3 sq km	0.3 sq km	0.3 sq km	0.3 sq km	0.3 sq km
PT	50 cu m	50 cu m	50 cu m	50 cu m	50 cu m
D	30 m	30 m	30 m	30 m	30 m
CS	30 No.	30 No.	30 No.	30 No.	30 No.
PS	10 No.	10 No.	10 No.	10 No.	10 No.
GP (IP, SP & Magnetic)	3 sq km	3 sq km	3 sq km	3 sq km	3 sq km

G S I - SOUTHERN REGION

TAMIL NADU

CLAY

Title: Re – Assessment of clay deposits in Kancheepuram and Tiruvallur Districts, Tamil Nadu.

Objective : To Re – Assess the clay deposits and to study the sedimentological history of Sri Perumpudur – Avadi Upper Gondwana basin.

Nature Quantum of work and time schedule

Sl. No	**Nature of work**	**Total Load envisaged**	**Proposal for XII Plan Period**					**Personnel**
			2012-13	**2013-14**	**2014-15**	**2015-16**	**2016-17**	
1.	LSM (1:25,000) (sq km)	500	100	100	100	100	100	
2.	DM (1:2000) (sq km)	3	0.6	0.6	0.6	0.6	0.6	
3.	SMPL (nos)							
	i.) Grab samples	250	50	50	50	50	50	2 GX5
	ii) Pit samples	750	150	150	150	150	150	
	iii) Sedimentological and heavy mineral studies.	150	30	30	30	30	30	1 GX5
	iv) Petrographic studies	150	30	30	30	30	30	
	v) Bulk sampling (for beneficiation)	5	1	1	1	1	1	

Title : Preliminary Investigation for clay deposits in kallamedu area, Ariyalur Taluk, Perambalur, District Tamil Nadu.

Objective : To Estimate the resource potential of Olive Green swelling clay for its Industrial utility and study their sedimentalogical characteristics

Nature Quantum of work and time schedule

Sl. No	**Nature of work**	**Total Work Load envisaged**	**Proposal for XII Plan Period**					**Geologists/surveyors**
			2012-13	**2013-14**	**2014 - 15**	**2015 - 16**	**2016 -17**	
1.	LSM (1:25,000) (sq km)	150	-	-	-	150	-	2 G 1 S
2.	DM (1:5000) (sq km)	1.0	-	-	-	1.0	-	
3.	Pitting and trenching (cum)	150	-	-	-	150	-	
	SMPL (nos)							
	i.) Grab samples	50	-	-	-	50	-	
	ii) Pit samples	150	-	-	-	150	-	
	iii) Sedimentological and heavy mineral studies.	150	-	-	-	150	-	
	iv) Petrographic studies	150	-	-	-	150	-	
	v) ICP - MS	20	-	-	-	20	-	
	vI) Micro Palaeontological / Palynological	20	-	-	-	20	-	

Title: Re – Assessment of clay deposits of Upper Gondwana Sediments of Trichnopalli Cretaceous Basin, Perambalur district, Tamil Nadu.

Objective : To Re – Assess the resource potential of clay deposits of Upper Gondwana sediments and to bring out their sedimentological characteristics..

Nature Quantum of work and time schedule

Sl. No	**Nature of work**	**Total Work Load envisaged**	**Target spread out for XII Plan Period**					**No. of Geologists/surveyors**
			2012-13	**2013-14**	**2014-15**	**2015-16**	**2016-17**	
1.	LSM (1:25,000) (sq km)	100	-	-	-	-	100	2 G 1 S
2.	DM (1:2000) (sq km)	AN	-	-	-	-	AN	
3.	Pitting (Cu.m)	150	-	-	-	-	150	
4.	Sampling (nos)							
	i) Grab samples	100	-	-	-	-	100	
	ii) Pit samples	150	-	-	-	-	150	
	iii) PCS	100	-	-	-	-	100	
	iv) Sedimentological studies.	30	-	-	-	-	30	
	v) Bulk samples	6	-	-	-	-	6	

PLACER MINERALS

TAMIL NADU

Title : Environmental impact assessment of placer mineral exploitation along Tamil Nadu coast.

Objective : 1. To study the impact of tsunami on placer mineral deposits along the coast.

2. To make an idea on the exploitation of placer beach placers.

Nature Quantum of work and time schedule

Sl. No	**Nature of work**	**Total Work Load envisaged**	**Work Proposal during XII Plan Period**					**No. of Geologists/surveyors**
			2012-13	**2013-14**	**2014-15**	**2015-16**	**2016-17**	
1.	Rec. traverse (1:50,000) (L.Km)	2000	-	-	-	1000	1000	
2.	Geol. Mapping (1:25,000) (sq km)	800	-	-	-	400	400	2 GX5
3.	Auger drilling (m)	2000	-	-	-	1000	1000	
4.	SMPL (nos)	2000	-	-	-	1000	1000	1 GX5
	Grain size analysis (Nos.)	200	-	-	-	100	100	
	Ore microscopy (Nos.)	200	-	-	-	100	100	
	SEM–ECX Studies (Nos.)	50	-	-	-	25	25	

LIMESTONE

ANDHRA PRADESH

Title :- Preliminary investigation for Limestone

1. In the areas (Palnad basin) around Dachepalli and Nadikudi in Guntur District Andhra Pradesh. (Toposheet Nos. 56P/10, 11, 14 and 15).
2. In the area (Palnad basin) around Macherla in Guntur District Andhra Pradesh.
3. In the area (Bhima basin) Basheerabad, near Tandur, Ranga Reddy district.
4. In the area (Cuddapad basin) Jammalamadugu and Banaganapalli, Cuddpah district and Kurnool district.

NORTH EASTERN REGION

Personnel	:	**2 G**
Title	:	Exploration for lime stone and dolomitic limestone South East of Dawki
Commodity code	:	
Keywords	:	Limestone, Dolomite, Drilling and Assessment, Cement, SMS, Chemical, LD Grade.
Objective	:	Exploration of lime stone and dolomitic limestone in Jowai-Muktapur Road, Jaintia Hills District, Meghalaya.

Personnel	:	**2 G**
Title	:	Assessment of sillimanite between Mairang-Langtor-Nongdong area, East Khasi Hills, Meghalaya.
Commodity code	:	
Keywords	:	Khondalite, basic granulite, garnet magnetite.
Objective	:	Assessment of sillimanite between Mairang-Langtor-Nongdong area, East Khasi Hills, Meghalaya.

Nature and Quantum of work and time schedule :

Nature of work	**Total Load envisaged**	**1. Expected year of Completion** **2. Circulation of final report**	**Work already completed**	**Work Proposal For FS 2012-14**
PGRS INT MAP LSM (1:12,500)	100 Sq.km 30 Sq.km	a) 2012 – 2014 b) September 2041	New Item	100 Sq.km 30 Sq.km
Bed rock sample	100 Nos			100 Nos
Pitting and trenching	50 Cum			50 Cum
Thin section	15 Nos.			15 Nos.

Personnel	:	**2 G**

Title	:	Exploration for lime stone, Litang Valley.
Commodity code	:	
Keywords	:	Larket North Block, Litang Valley, Limestone, Drilling and Assessment, Cement, SMS, Chemical, LD Grade.
Objective	:	Exploration of lime stone in the peripheral area of the Litang Valley limestone deposit.

Nature and Quantum of work and time schedule :

Nature of work	**Total Load envisaged**	**1. Expected year of Completion** **2. Circulation of final report**	**Work already completed**	**Work Proposal For FS 2012-14**
D. M (1:5,000)	3 Sq.km	a) 2012 – 2014 b) September 2041	New Item	3 Sq.km
Drilling (1 Rig)	1600 m			1600 m
Core sampling	600 Nos.			600 Nos.

EASTERN REGION

FS-2012-14

1.Title: Resource evaluation of **Apatite** and associated minerals in Lanka,Parbahal and Chholari areas of Purulia district W.B. **(G-4)**

Personnel required: 2G

D G M - KARNATAKA :-

PROPOSALS FOR EXPLORATION DURING THE XIITH FIVE YEAR PLAN

The Department is preparing the Five year rolling field programmes in a phased manner. The list of field programmes proposed is as follows:

1. Exploratory drilling for limestone deposits in parts of Malked of Sedam taluk and lewargi taluks of Bhima Basin, Gulbarga district.

2. Exploratory drilling for cement grade limestone in Melanahalli village Chik kanayakanahalli taluk, Tumkur district.

3. Investigation for quartz / quartzites in Desani village of Arsikere taluk of Hassan district.

4. Investigation for quartz / quartzites near Rayalpadu village of Srinivasapura taluk of Kolar district.

5. Investigation for Steatite / soapstone in Bylakeri and Hosahalli villages of C.N. Halli taluk, Tumkur district.

6. Survey and assessment of ornamental stones in Davanagere taluk, Davanagere district.

7. Survey and assessment of ornamental stones in Mulkalmuru taluk of Chitradurg district.

D G M, WEST BENGAL

PART - A

Items to be Continued during XII Plan

Sr No	Item of Work	Achievement
1.	Investigation for Kyanite and associated minerals in Salboni-Ichadih area Balarampur P.S., Distt. Purulia	Assigned Project Completed.
2.	Black Stone in Purulia District including search for new deposit (Kadampur, Kankarkiari)	Assigned Project Completed. Programme for new area will be continuing for XIIth Five Year Plan period.
3.	Quartz / Feldspar prospecting in Purulia district (Janipur).	Assigned Project Completed. Programme for new area will be continuing for XIIth Five Year Plan period.
4.	Prospecting of Pyrophyllite around Jinamonipur, PS Kashipur, Distt. Purulia.	Assigned Project Completed. Possible northern extension will be investigated in XIIth Five Year Plan period.
5.	Prospecting of Glass Sand around Kaliasota – Mahisnadi area, PS Neturia, Distt. Purulia.	Assigned Project Completed.
6.	Detailed exploration of Apatite, around Kutni, PS Manbazar, Distt. Purulia	Assigned Project Completed.
7.	Detailed exploration of Apatite, around Chirugora, PS Boro, Distt. Purulia	Assigned Project Completed.
8.	Geological exploration for the estimation of reserve of clay deposits in Onda, Taldangra,	Programme continuing for XIIth Five Year Plan period.

	Beliatore, Sonamukhi and Bankura – II areas of Bankura district, West Bengal.	
9.	Investigation of Quartz deposits including estimation of reserve in parts of Bankura district.	Programme continuing for XIIth Five Year Plan period.
10.	Investigation of Talc – Steatite of Gok – Karmi area, PS Pulbazar, Distt. Darjeeling. (It is a joint investigation programme of GSI, ER and DMM West Bengal)	Assigned Project Completed.
11.	Investigation for Talc – Steatite around Lapcha basti and Singla (in the extension areas of Gok – Karmi) of Distt. Darjeeling a collaborative Programme of GSI, ER and DMM West Bengal)	Programme likely to continue in XIIth Five Year Plan period (subject to the approval of CGPB)

PART - B

Exploration Programme likely to be undertaken during the 12th Plan Period (2012 – 2017)

Sr No	**Item of Work (Project)**	**Duration**	**Remarks**
1.	Prospecting for probable northern extension of the occurrence of Pyrophyllite around Phusra, P. S. Kasipur, Distt. Purulia.	One Year	Probable northern extension of the investigated mineralization of Jinamonipur will be assessed.
2.	Investigation for Quartz resources in parts of Purulia distt as per the guidelines of UNFC	Two Year	Continuing Project
3.	Geological exploration for reserve estimation of clay deposits in Bankura district, as per the guidelines of UNFC.	Four Year	Continuing Project
4.	Investigation of Quartz resources in parts of Bankura district.	Four Year	Continuing Project

5.	Investigation of Silica Sand resources in north eastern part of Bankura district.	Three Year	New Project
6.	Test drilling and Trenching for calibration of the Geophysical anomalies with Mineralization values of Quartz veins of Bankura district.	Two Year	Continuing Project
7.	Investigation for talc – steatite in different areas of Darjeeling district, West Bengal (preferably in collaboration with GSI, ER)	Five Year	Likely to Continue

D G M, RAJASTHAN

DRAFT PROPOSALS FOR THE 12TH FIVE YEAR PLAN

Although the detailed exercise for the formulation of the 12th Five Year Plan is underway, the broader outline for the Mineral Survey and Prospecting Scheme are as under :-

All the six plan schemes which were undertaken during the 11th Five Year Plan will further be continued during 12th Five Year Plan. However, few modifications are being proposed under the first fundamental IPS scheme as per the released State New Mineral Policy – 2011.

1.		**Intensive Prospecting and Mineral Survey Scheme :**
	(i)	As usual around 50 Nos of projects will be undertaken per annum for Mineral Survey and Prospecting for various minerals in the State.
	(ii)	As per State New Mineral Policy – 2011, delineation in Government land for various minor minerals has become mandatory, therefore, every year, a few projects will be planed and executed to take up systematic of suitable plots for minerals like sandstone, masonry stone, marble, granite, limestone (flooring) and schist stone / slate stone etc. This is a voluminous work involving identification of Government land, collection of revenue records, awareness generation amoung villagers, approval at Government level, subsequent notifications for leasing out of such delineated plots etc.
	(iii)	The exploration for cement grade and steel grade limestone will be further continued in parts of Jaisalmer, Nagaur, Chittaurgarh, Jodhpur and Pali districts so that proved blocks can periodically be declared free for establishment of major cement plants and related industries.
	(iv)	We will also propose a few projects for discovery and detailed exploration for important industrial minerals like gypsum, potash, fluorite, quartz, feldspar, soapstone, china clay, bentonite, siliceous earth, precious and semi-precious stones etc.
	(v)	We are constantly encouraging the entrepreneurs to invest in the mineral prospectting and in value addition.

MINERAL SURVEY PROPOSALS TO BE TAKEN DURING XII PLAN (2012-17) FOR INDUSTRIAL(LIMESTONE)AND FERTILIZER, MINERALS IN RAJASTHAN

Rajasthan contributed about 22% of industrial mineral production in the country along with production of approximately 15% in metallic, 25% non-metallic and 26% in minor mineral category. Minerals are currently being exploited in the state of which 37 are major minerals and 22 are minor minerals. Which contributed revenue of around Rs. 1929.58 crores to the state exchequer in the year 2010-11. The value of minerals produces from the state was over Rs. 8500 crores during 2010-11.

Department has recently notified 10 blocks of cement grade limestone for leasing in the districts of Chittaurgarh, Nagaur and Jaisalmer to establish major cement plants and continuing exploration for limestone in Nagaur, Chittaurgarh, Jaisalmer and Jaipur districts. 12 more blocks of cement grade limestone and about 8 blocks of SMS grade limestone have been proved by the department, which will be leased out in near future.

Limestone (Cement Grade):

Limestone produced in the state is used in cement manufacturing, in chemical industries and for lime burning. SMS grade limestone is also produced in the state which is used in the steel plants. Limestone is available in almost all parts of the state and huge reserves to the tune 19486 million tonnes (all grades) have been proved till now.

(a) With 6 major cements plants and two white cements plants, having a total capacity of more than 21 million tonnes per annum. Rajasthan is the second highest cement producing state in India.
(b) An investment worth Rs. 25000 crores is expected in the cement plants to be established in Rajasthan in the coming years.
(c) Mining lease of cement grade limestone will be allotted only for captive use by cement plants.

Limestone (SMS Grade):

About 2000 million tonnes of SMS grade limestone and high grade limestone reserves have been proved in parts of Jaisalmer, Nagaur, Jodhpur and Pali districts. SMS grade limestone is used as flux in steel plants. Year-wise physical target proposed for XII Plan period for above category of minerals is given below.

YEARWISE PLAN PROPOSALS OF MINERAL SURVEY AND PROSPECITNG FOR INDUSTRIAL, FERTILIZER, LIMESTONE CATEGORY OF MINERALS FOR XII-FIVE YEAR PLAN PERIOD

(Period 2012-13 to 2016-17)

Year	**RMS (sq.km.)**	**RGM (sq.km.)**	**DGM (sq.km.)**	**Drilling (m.)**	**Geophysical (L.Km.)**
	Targets	**Targets**	**Targets**	**Targets**	**Targets**
2012-13	1050	105.00	10.00	-	-
2013-14	950	105.00	11.00	-	-
2014-15	800	80.00	8.00	600	-
2015-16	750	75.00	7.50	600	-
2016-17	700	70.00	7.00	600	-
Grand Total :	**4250**	**435.00**	**43.50**	**1800**	**-**

DGM- MAHARASHTRA

Sl. No.	Year	Industrial & Fertilizer Mineral/Name	District	Nature of work Mapping/Drilling
1.	2012-13	Pyrophylillite / Silimanite	Chandrapur	20.00 Sq.km. mapping 800.00 m Drilling
2.	2013-14	Pyrophylillite / Silimanite	Chandrapur	20.00 Sq.km. mapping 800.00 m Drilling
3.	2014-15	Pyrophylillite / Silimanite	Chandrapur	20.00 Sq.km. mapping 800.00 m Drilling
4.	2015-16	Pyrophylillite / Silimanite	Chandrapur	20.00 Sq.km. mapping 800.00 m Drilling
5.	2016-17	Pyrophylillite / Silimanite	Chandrapur	20.00 Sq.km. mapping 800.00 m Drilling