



## **INTRODUCTION**

Geological Survey of India, Southern Region (SR) was set up in November, 1961 under the Directorship of K. R. Khedkar.

The Southern Region Office comprises (i) State Unit Andhra Pradesh at Hyderabad; (ii) State Unit Tamil Nadu & Puducherry at Chennai; (iii) State Unit Kerala at Thiruvananthapuram; and (iv) State Unit Karnataka & Goa at Bengaluru. After implementation of the HPC recommendations and Mission mode operations in SR, the activities of three Marine and Coastal Surveys (M&CS) Divisions (Kochi, Mangalore and Visakhapatnam) under Mission 1A, two Divisions of Coal and Lignite under Mission II B--Natural Energy Resource (NEnR) and two units of Remote Sensing and Airborne Surveys (RSAS—Hyderabad and PPOD, Bangalore) under Mission IB have been included in SR.

## **GEOGRAPHIC EXTENSION**

Southern Peninsular India comprising States of Andhra Pradesh, Karnataka, Kerala, Goa, Tamil Nadu and the Union Territory of Puducherry exposes diversified lithological assemblages from Archaean to Holocene. It is divisible into four physiographic units namely, (i) East and West Coastal Plains, (ii) Eastern Ghats, (iii) Deccan Plateau and (iv) Western Ghats. The area comprises mostly Deccan Plateau, flanked by linear stretches of coastal plains and is drained by major easterly flowing rivers like the Godavari, Krishna, Tungabhadra, Pennar, Palar, Cauvery and Vaigai, and a few westerly flowing rivers such as Mandovi, Zuari, Netravathi, Bharathapuzha, Periyar and Pamba, which originate from the Western Ghats.

### **SU: Andhra Pradesh:**

The State of Andhra Pradesh has an area of 2, 76,800 sq km and is bounded by N lat. 12o45' -19o50' and E long. 76o 54'-84o 45'. Physiographically, the State comprises hill ranges, plateaus, deltas and coastal plains. The State is divisible, from east to west, into three distinct units viz. (i) the coastal plains, interspersed with deltas of the major rivers like Godavari, Krishna and Penner, to the east (ii) the Eastern Ghats (prominent in the north) and Nallamalai hill ranges (prominent in the south) to the west and (iii) the undulating plateau region dotted with hill ranges to the western most.

**SU: Karnataka & Goa:**

The State of Karnataka occupying an area of 1, 91,792 sq km is bounded by north latitudes 11°32' and 18°30' and east longitudes 74°05' and 78°32', whereas the State of Goa bounded by north latitudes 14°54' and 15°48' and east longitudes 73°48' and 74°20' along the West Coast between Western Ghats and Arabian Sea has an area of 3,701 sq km.

**SU: Tamil Nadu & Puducherry:**

Tamil Nadu is located in the southeastern part of the Indian Peninsula between 08°00' and 13°30' N and 76°00' and 80°18' E. The State covers a total area of 1,30,058 sq km. The Union Territory of Puducherry is located on the East Coast, about 160 km south of Chennai and occupies an area of 492 sq km.

**SU: Kerala:**

The State of Kerala bounded by Latitudes 8°17' and 12°47' N and Longitudes 74°52' and 77°25' E, forms a 38,864 sq km linear stretch of land, along the southwest coast of India. Four broad physiographic units are discernible from west to east - (i) low-lying coastal plains fringing the Lakshadweep Sea, (ii) laterite-capped midland region between 30 and 200 m above MSL, (iii) foothills of the Western Ghats between 200 and 600m above MSL and (iv) the hill ranges of the Western Ghats rising to heights of 2500 m above MSL.

## **GEOLOGICAL MILIEU OF SOUTHERN INDIA**

### **Archaean to Proterozoic**

Southern peninsular India is a shield area comprising Dharwar Craton in the north and Southern Granulite Terrain in the south; a boundary called the Fermor Line separates these two. Dharwar Craton encompasses major parts Karnataka and Andhra Pradesh States. Dharwar Craton is a typical Archaean-Proterozoic granite-greenstone terrain. An array of granitic lithounits such as tonalite, trondhjemite, granodiorite, adamellite and granite constitute this Archaean-Proterozoic granitic terrain. They are frequently deformed into complex gneisses. The granitic rocks of varying composition and their gneiss are together known as Peninsular Gneissic Complex (PGC). The PGC contains several linear, deformed and folded greenstone / schist belts. Prominent intra-cratonic Proterozoic sedimentary basins namely Cuddapah Basin, Kurnool Basin, Bhima Basin and Kaladgi Basin have formed over the basement of Dharwar Craton. The craton is bounded in the east by Eastern Ghats Mobile Belt, in the northeast by the Bastar Craton, and is overlain in the northwest by the basalt flows of Deccan Trap. Eastern Ghats Mobile Belt is a granulite terrain made up of charnockite, khondalite, quartzite, calc-granulite, pyroxene-granulite, granite and leptynite. This belt extends into Orissa in a northeasterly direction. In the northern part, Dharwar Craton is partly covered by Proterozoic sediments of Pakhal Supergroup and Phanerozoic sediments of Gondwana in a NW-SE trending rift basin called as Godavari Basin / Rift / Graben. They are flanked on either side by Proterozoic sedimentary sequences of Penganga and Sullavai basins.

### **Palaeozoic and Mesozoic Sediments:**

Rocks of Gondwana Supergroup are exposed along the Pranhita-Godavari valley in Andhra Pradesh. In Tamil Nadu coast, basins containing Phanerozoic sediments are well developed in the Palar basin. Mesozoic rocks are exposed in five sub-basins along Tamil Nadu-Puducherry coast; these are Palar, Puducherry, Vriddhachalam, Tiruchirapalli and Sivaganga sub-basins. Gondwana sediments of the Godavari Valley host rich coal deposits in Andhra Pradesh. Lignite deposit occurs in Neyveli area in Tamil Nadu.

### **Deccan Trap:**

Basalt flows of Deccan Trap with their infratrappean and intertrappean sedimentary beds, cover a vast area of Karnataka and Andhra Pradesh over an area of about 42,000 sq km in the northern and northwestern parts of SR. Adilabad, Nizamabad, Medak, Ranga Reddy, Mahbubnagar, East Godavari and West Godavari districts of Andhra Pradesh, and Bidar district and parts of Belgaum, Bijapur and Gulbarga districts in Karnataka expose Deccan Trap.

### **Tertiary Sediments:**

Tertiary sedimentary sequence in Andhra Pradesh is represented by Rajahmundry Formation, along the coast between Samarlakota and Eluru. In Tamil Nadu, Tertiary sediments are associated with Ariyalur Group in Tiruchirapalli, Puducherry and Cuddalore areas.

### **Quaternary and Holocene Sediments:**

The Quaternary sediments in the southern peninsular India occur along the coastal tracts and inland river valleys by narrow continuous palaeo-beach ridges, interrupted by the prograding deltas of major rivers. They are represented by thick blankets of alluvium, gravel and colluvial deposits, beach sand, kankar, soils of various types and laterite.

## **GEOLOGICAL MILIEU OF DIFFERENT STATE UNITS**

### **SU: Andhra Pradesh:**

A major part of the State forms the Peninsular Shield referred to as Dharwar Craton, which comprises Late Archaean granite-gneiss and a few widely separated narrow greenstone belts, especially in the south and west. The Craton is bounded by the Eastern Ghats Mobile Belt to the northeast and the Pranhita- Godavari Valley to the north. The Proterozoic sedimentary sequence, Cuddapah and Kurnool, occupy large tracts in the south-central part. The Pranhita-Godavari valley exposes a sequence of sedimentary rocks ranging in age from Proterozoic to Cretaceous. The Gondwana sediments of Pranhita- Godavari Valley are the only coal bearing formations in South India. The Deccan Trap effusive covers some of the formations in the northwest and west. The isolated Cretaceous - Tertiary outcrops and the Quaternary alluvial covers occupy the coastal belt, which hosts sizeable reserves of oil and natural gas- both onshore and offshore. Tertiary laterite capping are conspicuous along the coast and also over the Eastern Ghats. The East Coast Bauxite deposits, one of the biggest deposits of Asia, occur as capping on the Eastern Ghats. The State has huge reserves of bauxite, limestone, coal, barytes and dimension stones and is a leading producer of these minerals. Other minerals of commercial significance

that occur in the State include apatite, basemetals, clay, diamond, gold, graphite, manganese, mica, petroleum and natural gas, quartz, silica & radioactive sands, garnet, feldspar, beryl, ruby, slate, marble, rare earth elements and radioactive minerals.

**SU: Karnataka & Goa:**

The geological milieu exposed in these States is Archaean Greenstone-Granite suite overlain by a litho-package of Dharwar Supergroup, Proterozoic basins (Kaladgi, Badami and Bhima) besides Cretaceous-Eocene basaltic lava flows representing Deccan Traps. The laterite capping of Tertiary period is conspicuously noticed on the rocks along the coastal plains and atop the Deccan Traps. Pleistocene to Holocene Formations also occurs at places, along the West Coast.

Karnataka is the principal producer of gold, manganese ore, iron ore and limestone. Other important minerals that are noticed are basemetals, chromite, dolomite, soapstone, clay, precious and semi-precious stones and dimension stones.

**SU: Tamil Nadu & Puducherry:**

Archaean to late Proterozoic crystalline rocks occupy about 80% of the area. Phanerozoic sedimentary rocks and Quaternary sediments cover the rest of the area, mainly along the coastal belt. Rocks of Charnockite and Khondalite Groups and their migmatitic derivatives, supracrustal sequences of Sathyamangalam and Kolar Groups and Peninsular Gneissic Complex, intruded by mafic– ultramafic complexes, basic dykes, granites and syenites comprise the hard rock terrain (1,07,799 sq km). The sedimentary rocks of the coastal belt include fluviatile, fluvio-marine and marine sequences ranging in age from Carboniferous to Mio-Pliocene and sediments of Quaternary age. The chief mineral resources of Tamil Nadu are fossil fuels (lignite, petroleum and natural gas), metalliferous minerals (iron ore, bauxite, gold, platinum, molybdenum and poly-metallic sulphides) and non-metallic and industrial minerals (limestone, dimension stone, magnesite, ceramic raw materials, graphite, gypsum, heavy mineral, silica sands, vermiculite, quartz, feldspar and gemstones). There is scope for getting coal bed methane in the deep level lignite beds.

**SU: Kerala:**

Hard crystalline rocks occupy about 35,955 sq km of the total area and the remaining 2,909 sq km by sedimentary formations. Precambrian crystalline rocks belonging to the Wayanad Group (equivalent to the Sargurs), Khondalite and Charnockite Groups and Peninsular Gneissic Complex are the major rock types found in the midland and highland regions. Younger acid and basic intrusives traverse the above rock units. Sedimentary rocks belonging to Tertiary Warkalli Formation form linear and detached outcrops all along the west coast. Quaternary formations are extensively found in the coastal plains and major river valleys. Economic mineral deposits reported in the state includes china clay, heavy mineral-rich beach sand containing ilmenite, rutile, monazite, zircon, garnet, sillimanite etc, bauxite, glass-sand, iron-ore, limestone, lime shell, gold, graphite, dimension stones, gems and semi-precious stones.

Kerala State has heavy mineral sands along the coast and rich clay deposits. The economic clay deposits in Kerala are of residual and sedimentary clays are found. The residual clay is a weathering product of

the feldspars in the gneisses and granites. Sedimentary clay is found in association with Tertiary sedimentaries along the coastal belt of Kerala. Kerala is an important producer of kaolinitic clay, ball clay and china clay. Mining of clay is confined to Thiruvananthapuram, Kollam, Ernakulam, Kannur and Kasargod districts. The State produces annually an average of 1.08 lakh tonnes of processed china clay forming 9.08% of the country's annual production. Fire clay and ball clay are also mined in the state. The heavy mineral deposits dominated by ilmenite and monazite are confined to sandy beaches of coastal stretches.

The occurrence of large quantity of ilmenite and monazite in the coastal sands of Varkala and Chavara in Kollam district is well known. The sandy beach west of Nirkunnam (to south of Trikkunnapuzha) in Alappuzha district forms the northern continuation of the famous Chavara heavy mineral deposit. These deposits are worked by Kerala Minerals and Metals Ltd. and Indian Rare Earths Ltd. In Malappuram District, the coastal tract between south of Ponnani to Balangod is endowed with 915,000 tonnes of ilmenite, 180,000 tonnes of magnetite, 230,000 tonnes of garnet and 4000 tonnes of zircon. Thiruvananthapuram district deposit of ilmenite and monazite in beach sands are found in Vizhinjam, Kovalam and near Veli and Varkala. The AMD has estimated a reserve of 3.33 million tonnes of heavy minerals from these areas out of which ilmenite constitutes a reserve of 2 million tonnes. Apart from these GSI has proved the probable resources of Ilmenite-0.9 million tonnes, Rutile-0.07 million tonnes, Zircon-0.06 million tonnes and Sillimanite-0.3 million tonnes. in the inner shelf areas of Kollam-Varkala sector. Other occurrences include bauxite, iron ore, graphite, limestone and gold.

### **MINERAL RESOURCES OF SOUTHERN REGION**

The southern Indian States are endowed with rich mineral wealth. Significant mineral deposits such as ferrous, non-ferrous and noble metals, precious and semi-precious stones, strategic minerals, fossil fuels and other industrial minerals are found in diverse geological formations ranging from Archaean to Quaternary. The Archaean high grade metamorphic rocks such as Sargur Group hosts mica, copper, barytes and gemstones; the greenstone belts of Dharwar Craton are repositories of gold and iron ore; Peninsular Gneissic Complex is the host for diamondiferous kimberlite pipes, apart from bearing potential for dimension stones, chromite and semi-precious stones. Granulites of Eastern Ghats Supergroup and Southern Granulite Terrain contain bauxite, manganese, graphite, apatite, gemstones, tungsten and dimension stones. The Proterozoic rocks that are confined in the intra-cratonic basins, contain basemetals, barytes, asbestos, limestone, dolomite, diamonds, iron and manganese ores, magnesite, phosphorite and uranium. Late Palaeozoic to Early Mesozoic rocks of Gondwana Supergroup contain coal deposits and clay. The Tertiary and Quaternary rocks contain oil and natural gas, lignite, beach sands, clay, diamond and other gemstones. The mineral deposits linked to the growth of Gross Domestic Product (GDP) are limestone, bauxite, barytes, coal, lignite gold, diamond, dimension stones, manganese, mica, oil and natural gas.

**Andhra Pradesh (AP)** has large reserves of different grades of limestone (about 13,000 million tonnes). It accounts for nearly 25% of the country's limestone resources. About a quarter of the country's cement production takes place in 34 cement plants that are in operation in Andhra Pradesh. The cement production is of the order of 12 Mt / annum. Besides cement grade limestone, significant reserves of BF, SMS and high-grade limestone is also found. AP stands next to Orissa in bauxite reserves. Good quality bauxite, with significant aluminium-content occurs as high-level cappings over the khondalite and granulites. The reserves of bauxite estimated in these districts are to the tune of 565 Mt.

The deposits in AP and Orissa with a total reserve of about 1650 Mt constitute one of the largest bauxite deposits in the world. The largest barytes deposit in the world with a reserve of 74 Mt is located in Mangampeta in Cuddapah District. This deposit occurs in the Pullampet Shale of the Cuddapah Super group. The state possesses reserves of coal estimated up to 1200 m depth are of the order of 13020 Mt, from coal bearing formations in Godavari Valley. Archaean greenstone belts are the major repositories of gold. They occur as linear, narrow and subparallel N-S to NNW-SSE trending schist belts amidst Peninsular Gneissic Complex. Andhra Pradesh has the distinction of having produced many of the historically famous diamonds like the Koh-i-noor, the Great Mogul, the Hope and the Orloff. Both primary (kimberlites / lamproites) and secondary (conglomerates and gravel) source rocks of diamond occur in different parts of the State. Andhra Pradesh has immense potential for granite based dimensional stone industry. The Archaean-Proterozoic granite-gneiss terrain occupying more than 60% of the state is a storehouse of multi-coloured rocks of which the Galaxy Granite (hypersthene-gabbro-norite) occurring in Prakasam district has high export potential. The State contributes about 90% of the manganese ore production in the country. The ore is mainly associated with kodurites of Khondalite Group in Eastern Ghats Supergroup and Penganga beds in the Pakhal Basin. At the national level, Andhra Pradesh occupies eighth position in mineral production with a share of about 8%. Apart from these mineral commodities significant prospects of oil and natural gas have been identified over an area of about 40,000 sq km on-shore and off-shore in the Krishna-Godavari basins in parts of East and West Godavari and Krishna districts. The State is endowed with significant occurrences of strategic minerals/metals, which include monazite, ilmenite, tungsten, uranium and molybdenum. These are found in various geological environments. A number of occurrences of precious and semiprecious stones are known from gem belt in the Eastern Ghats, distributed in East Godavari, Visakhapatnam and Vizianagaram districts.

**Tamil Nadu** is endowed with several varieties of minerals. The important minerals are fossil fuel lignite associated with Cuddalore Formation in Cauvery basin, metalliferous minerals such as base metals, for eg., poly-metallic and iron-sulphide mineralisation in Mamandur of Cuddalore District. The state has bauxite reserves occurring as irregular lenses - pockets and high-level laterite cappings over charnockite in the Nilgiri Hills, Shevroy Hills, Kollimalai Hills, and the Palani Hills. Layered Mafic and ultramafic complexes of the State are the repositories of chromite deposits mainly occurring in Sittampundi and Karungalpatti in Salem District and Karappadi, Mallanayakanpalayam and Solavanur in Coimbatore district. Gold occurs in the Nilgiri district. The State possesses reserves of over 500 million tonnes of magnetite, with an average grade of 38% iron for the major deposits occurring in Salem, Vellore, Tiruvannamalai, Villupuram, Dharmapuri, Thiruchirappalli, Namakkal and Perambalur districts. Molybdenum mineralisation occurs in two different geological settings - one associated with the alkaline group of rocks like in Harur- Uttangarai - Alangayam belt in Dharmapuri and Vellore districts and the other in a graphite pegmatite intrusive into migmatitic gneiss of Karadikuttam area of Dindigul District. The state is endowed with reserves and resources of non-metallic and industrial minerals such as apatite occurring in hybrid rocks (syenite-pyroxenite) and in the carbonatite near Sevattur, Vellore District, with reserves of 190,000 tonnes. Phosphatic nodules occur in association with gypseous clay and shale of Karai Formation of Uttattur Group of Cretaceous age, in Tiruchirappalli district. A total probable reserve of 127,000 tonnes was estimated. The P205 content of the nodules varies from 21.14 to 26.50%. Tamil Nadu is the dimensional capital of the country, with various varieties of commercial deposits, with estimated probable resource estimate of dimension stone granites during Phase-I investigation (1992-97) of around 23.62 million cu m. The projected minimum export of around 250,000 cu m. in the next five years is likely to bring in foreign exchange of about 120 million U.S. Dollar. Graphite occurrence is located in Puvandhi in Sivaganga District, Kurinjankulam in Tirunelveli District, Palakottai Hill and near Pudupalaiyam in Vellore District and Tirumangalam, Ponnangalam in

Madurai district. Reserves are estimated of over 0.6 million tonnes of graphite concentrate in Tamil Nadu. Gypsum reserves of 15.60 million tones are reported from Perambalur in Perambalur district and Lalgudi taluk in Tiruchirapalli district. The State has major heavy mineral deposit (ilmenite, rutile, monazite and garnet-bearing sands) associated with the beach sands spread along its vast coastal tracts. Major concentration of these heavy minerals occur along east coast between Kolachal and Kanyakumari in Kanyakumari district with reserves of 45,75,605 tonnes, as reported by Atomic Minerals Division (AMD), apart from these 93,60,093 tonnes of heavy mineral deposit have been estimated by the (source AMD) between Periaswamipuram and Vembar Naripaiyur in Ramanathapuram district.

Substantial limestone deposits occur in Tamil Nadu both as crystalline and non-crystalline (amorphous) varieties besides corals. The bulk of limestone deposits of are mainly distributed in parts of Salem, Tiruchirapalli, Karur, Madurai, Virudhunagar, Ramanathapuram, Nagapattinam, Tirunelveli, Tuticorin and Coimbatore districts. The total reserves of crystalline limestone are 200 million tonnes of 'Proved' category and about 25-30 million tonnes of 'Inferred' category. Non-crystalline limestones are located in parts of Tiruchirapalli, Tirunelveli and Tuticorin districts with reserve base of about 670 million tonnes of both 'proved' and 'inferred' categories of which 650 million tonnes of Cretaceous age distributed in erstwhile Tiruchirapalli district while rest are of Tertiary age distributed in Tirunelveli District. Coral limestone is found in a series of islands in Gulf of Mannar, Palk Bay and Rameswaram. Prominent deposit of magnesite is located on Chalk Hills as criss-cross veins traversing dunite / peridotite in Salem district with estimated reserves of at 44 million tonnes. Apart from these, other commodities like asbestos, barytes, clay, corundum, feldspars, gemstones, mica, ochre, moulding / glass sand, quartz, sillimanite, steatite and vermiculite are also present. Minor occurrences of minerals such as beryl, celestite, columbite-tantalite, garnet, ilmenite, kankar, nickel ore, pyrite, allanite and salt are also recorded

In the Union Territory of **Puducherry**, ilmenite and garnet sands occur along the coast of Karaikal with reserves of 17,26,862 tonnes (source AMD).

**Karnataka** State is well known for its gold deposits, apart from manganese, iron ore and limestone in the country. 64 percent of the total gold resource is contributed by Karnataka and this forms the bulk of the known gold resource of the country. The mines in the Kolar Gold Fields (KGF) and the Hutti mines accounted for about 98% of the primary gold production in India in 1992. The well known Kolar Gold Field has a long record of continuous production since 1880 with a peak production of 19,565 Kg in 1905 and has so far produced 815 tonnes. Much of the mineralisation so far identified in the Kolar, Hutti-Maski, Gadag and Chitradurga schist belts is shear-controlled, but the gold is also hosted in a variety of litho-packs associated with schist belt and adjoining rocks. The State has the largest recoverable reserves of manganese ore in the country. Manganese ore minerals occur in close association with haematite and carbonates as stratiform, lenticular, patchy or pockety deposits of varying dimensions, within various greenstone belts. Karnataka is endowed with a number of major iron ore deposits. The iron ore deposits of Karnataka are principally of two types. (i) Lateritoid concentrations, essentially of haematite with minor limonite and goethite. Major deposits of haematite occur in Sandur, Chitradurga and Shimoga schist belts in Bellary, North Kanara, Chikmagalur, Shimoga, Chitradurga and Tumkur districts. (ii) Magnetite deposits occur in Bababudan and Western Ghat schist belts in Chikmagalur, Shimoga and North Kanara districts. Magnetite occurs in Bababudan Group as lenses or as beds in the banded-magnetite-quartzite. Extensive deposits of high-grade limestone occur in the Proterozoic sedimentary basins such as Kaladgi and Bhima basins in parts of Belgaum, Bijapur and Gulbarga districts. While cement grade, BF (Blast Furnace) grade, SMS (Steel Melting Shop) grade and chemical grade limestone occurs in the Lower Bagalkot Group of Kaladgi Supergroup, the cement grade limestone is

reported from Bhima basin with reserves of 12181mt. Karnataka has substantial resources of haematite, bauxite, chromite, dolomite, and quartz and silica sand, along with various types of clay, Fuller's earth, titaniferous / vanadiferous magnetite, talc and steatite (soapstone).

**Goa** has economic mineral deposits, particularly iron and manganese ores. The in situ reserves of about 967 million tonnes of haematite, 187 million tonnes of magnetite and 83.1 million tonnes of manganese ore; they constitute 8.00%, 3.08% and 22.4% of the total resources estimated in the country. Due to their proximity to the sea port, they are mined extensively for export. Besides iron and manganese, a number of deposits of bauxite, silica sand, low grade limestone, clays, low grade chromite and quartzite are also known from Goa.

**Kerala** State has heavy mineral sands along the coast and rich clay deposits. The economic clay deposits found in Kerala are of residual and sedimentary clays are found. The residual clay is a weathering product of the feldspars in the gneisses and granites. Sedimentary clay is found in association with Tertiary sedimentaries along the coastal belt of Kerala. Kerala is an important producer of kaolinitic clay, ball clay and china clay. Mining of clay is confined to Thiruvananthapuram, Kollam, Ernakulam, Kannur and Kasargod districts. The State produces annually an average of 1.08 lakh tonnes of processed china clay forming 9.08% of the country's annual production. Fire clay and ball clay are also mined in the state. The heavy mineral deposits dominated by ilmenite and monazite are confined to sandy beaches of coastal stretches.

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## **THE IMPORTANT ACTIVITIES OF SOUTHERN REGION IN MISSION MODE**

### **1) Mission – I**

#### **Mission IA**

- i) Systematic geological mapping/specialised thematic studies.
- ii) Geochemical mapping.
- iii) Geophysical mapping/surveys.
- iv) Marine and Coastal Surveys

#### **Mission IB**

- v) Geomorphological Surevy
- vi) Hyperspectral Survey
- vii) Airborne Mineral Survey
- viii) Photogeology and Remote sensing

**II) Mission –II**

**Mission -IIA**

- ix) Mineral Resource assessment.

**Mission -IIB**

- x) Natural Energy Resource (Coal and Lignite)

**III) Mission- III**

- xi) Geodata and Geoinformatics
- xii) Map compilation and Map Publication
- xiii) Publication and Information Delivery

**IV) Mission- IV**

- xiv) Geotechnical studies.
- xv) Earth-quake geology studies.
- xvi) Fundamental Geoscience- Petrology, Palaeontology and Mineral Physics.

**V) Mission- STSS**

- xvii) Laboratory support
- xviii) IT infrastructure connectivity
- xxi) Chemical Laboratory support
- xx) Drilling
- xxi) Transport
- xxii) Survey
- xxiii) Technical Consultancy Service.

**Administrative Support System:**

- xxiv) Finance
- xxv) Personnel
- xxvi) Legal Cell
- xxvii) HRD
- xxviii) Information and Publications
- xxix) Libraries, Parks and Museums
- xxx) Estates

**Policy Support System:**

- xxxi) Science Policy & coordination
- xxxii) Planning & Monitoring
- xxxiii) CGPB Secretariat
- xxxiv) International cooperation
- xxxv) Commercial Operations
- xxxvi) Geoscience partnerships

**LABORATORY CAPABILITIES**

Geological Survey of India, Southern Region is equipped with:

- 1) Sophisticated instruments for chemical analysis like
  - Atomic absorption spectrophotometer (AAS)

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- Inductively coupled plasma-atomic emission spectrometer (ICP-AES)
  - Inductively coupled plasma mass spectrometer (ICP-MS)
  - Fire assay furnace.
  - XRF
- 2) Electron Probe Micro Analysis (EPMA) for mineral grain studies.
  - 3) Mineral separating facility including isodynamic separator in Petrology Lab.
  - 4) X-ray Diffraction (XRD) machine for study of clay minerals
  - 5) Scanning electron microscope (SEM) for palaeontological studies.
  - 6) Binocular stereo-zoom microscope for petrological study.
  - 7) Ore microscopes for identifying ore minerals (in Petrology Division)
  - 8) Digital image processing software for remote-sensing in PGRS lab.
  - 9) Gem testing facility in the Gems unit of PGRS lab.
  - 10) Rock testing for physical properties in engineering geology studies in Geotechnical Lab.
  - 11) Pulverizers and Crushers for rock sample powder preparation

**IMPORTANT LABORATORIES LOCATED IN SOUTHERN REGION AND CAPACITY OF EQUIPMENT**

S.No.	Name/ Type of Equipment available	Type of Analysis	No of samples analysed per month (Optimum Conditions)
<b>Chemical Laboratory, Hyderabad</b>			
1	ICPMS	REE, PGE, Other Traces & Ultra Trace Elements	500
2	XRF	Major, Minor & Trace elements	300
3	ION ANALYSER	FLUORIDE	200
4	AAS-FLAME	Major, Minor & Trace elements	500
5	AAS-GTA	Au, Ag & Cd	1000
<b>Petrology Lab</b>			
1	AAS-GTA	Chemical analysis of silicates and ores.	30 analyses were done as a test case after the installation
2	DMRXP Microscope	Petrographic studies.	80 thin/ polished sections were studied.
3.	Polariscope, Refractometer, specific gravity instrument and microscope	Gem testing	Samples on request
<b>Geotechnical Lab</b>			
<b>Soil mechanics</b>			
1	Direct shear test	Determination of Cohesion and	130

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	apparatus	angle of Internal friction of soil samples	
2	Cone Panetrometer	Determination of Liquid Limit of soil samples	141
3	Pippet Assembly	Determination of clay size fraction of soil	56
4	Sieve shaker	Determination of grain size analysis of soil	65
5	Pycnometer	Determination of specific gravity of soil	58
<b>Rock mechanics</b>			
6	Uniaxial compression testing Machine	Determination of Compressive strength and tensile strength of rock/ core	25
7	Point Load testing Machine	Determination of Compressive Point Load strength Index of rock/ core	3
8	Los Angeles Abrasion Testing Machine	Determination of Abrasion Loss of aggregates	3
9	Core cutting Machine	For side cutting of cores	50

<b>PPOD Lab, Bangalore</b>			
1	ICP- AES (Simultaneous, Ultima-2, (Jobin –Yvon, France)	Major & trace elements Analysis (Al, Ca, Fe, Mg, Mn Ba, Sr, Ce, La, Ce, Sc, V & Y)	62 samples. R&D work carried out to find out methodology for Boron analysis for NGCM sample 69 samples
2	<b>AAS-Flame</b> Hydride Generator accessory GBC, Avanta-PM, Australia	Base metals & trace elements Cu, Pb, Zn, Ni, Co, As, Sb, Bi, Mo, Cd, Cr, Ag, Li & Cs	188 samples 496 samples 448 samples
3	<b>AAS-Flame</b> Varian SpetrAA-30 Australia	Cu, Pb, Zn, Ni, Co, Ag & Au	450 samples Not working Not working
4	<b>AAS-GTA,</b> GBC, Avanta- Sigma Spectrometer 240 system 30 Australia	Au, Pt Pd	Nil
5	<b>Pulverier</b> a) <b>BICO, INC,</b> b) Vibratory Cup Mill In smart systems, India	Utilizing for powdering of samples 25-30 years old (working with frequent repair)  Utilizing for powdering of samples	Appx. 400 samples/ month  Appx. 400 samples/month

	<b>PPOD Lab, Bangalore</b>		
1	<b>Petrology/ Ore Microscopy</b> Leica DMRXP Trinocular advanced research polarizing microscope for transmitted and reflected light with photomicrography attachment and digital image processing and analysis workstation- One.	Study of thin and polished sections	30 to 40 samples per month
	Petrological Microscope: Two- LABOPHOT, NIKON, One- Leitz Attachments for digital microphotography	Study of thin and polished sections	
	Leitz Orthoplan Microscope for reflected and transmitted light with photomicrography attachment- One	Study of polished sections	
	Digital Point counter M/s Electrotrade, Kolkata	Mineral modal analysis	
	<b>Section Preparation</b> Water rock cutting machine-Two Kerosene rock cutting machine-Te Polishing cum grinding machine- One Polishing machine- One	Preparation of thin, thin polished, polished, grain mount sections and doubly polished wafers.	30 to 40 samples per month
2	<b>XRF and XRD</b> X-ray sequential Spectrometer (X' Unique II- Philips )	Determination of major (oxides) and trace elemental composition of rocks and metals.	60 to 70 samples per month
	Automatic fusion bead preparation Unit (Perl'X-3 Philips)	Preparation of fusion beads for XRF analysis	
	Hydraulic press pallet machine	Preparation of pressed pallets for XRF analysis	
	XRD SYSTEM (X'PERT PRO: PANALYTICAL)	Qualitative determination and characterization of the various mineral phases including clay minerals present in all geological samples.	25 to 30 samples per month

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3	<b>Mass spectrometry*</b> Isotope Ratio Mass Spectrometer (GEO 20-20; Ser Con) * Under repair and likely to be operational by Oct. 2010.	Stable isotopic analysis of C and O in carbonates, S in sulphides, N in nitrates and H/D in water system.	30 samples per month
4	<b>Fluid Inclusion Study</b> Olympus BX 50 microscope with LINKAM heating and freezing stage. (M/s Linkam scientific instruments Ltd.)	To record the Pressure, Volume, Temperature and Composition of the fluids in the inclusions in geological samples.	10 to 15 samples per month (presently no officer available)
5	<b>Ore dressing and mineral separation</b> Wilfley table, Mozley lab mineral separator, Fantz isodynamic separator, Knelson gold concentrator, Double cone blender, Forced hot air oven etc.	Separations of heavy minerals	50 to 60 samples per month (presently no officer available)
	Motorised Zoom Fluorescence Stereo Microscope (LEICA Mz16 FA) with image analyser.	Heavy minerals study under visible and UV light and their photomicrography.	
6	<b>Preparation of Certified Reference Material</b> 1) High capacity ball mill. 2) Planetary ball mill. 3) Polygonal Blender, 4) Forced air oven, 5) Rotary divider 6) Temperature and humidity controlled sample room	Preparation of contamination free bulk samples for preparation of certified reference materials (CRM).	Two bulk samples per year
7	<b>EPMA</b> Electron Probe Micro Analyzer CAMECA SX 100	Mineral chemistry (major, trace and REE), X-ray mapping, BSE imaging monazite (chemical) dating, etc.	40 to 50 hours per month
	<b>Palaeontology Lab, Hyderabad</b>		
1	<b>SEM-EDX</b>	Micrographs	30

### **ONGOING PROJECTS/ THRUST AREAS IN SOUTHERN REGION**

Field Programmes in the Region have been formulated in accordance with the departments priorities as per XI Plan document, recommendations of the central and state geological programming boards and in tune with the decisions taken by the Stage and Mid term Review committees of GSI. Mineral potential of Southern Region States has been estimated by GSI over the years. Ever increasing demand for this non renewal natural resource compels the geoscientist to go in search of new areas of mineral occurrences in the country. Accepting the challenge, GSI is now making every effort to look for the concealed mineral deposit, if any, which might have been missed during the course of surface mapping. Systematic geochemical mapping proved to be one of the best methods to get some clues on mineral occurrence in remote and inaccessible areas as well as on the buried deposits. GSI, therefore, is carrying out NGCM work on a large scale giving priority to the known mineral belt areas. First generation geological mapping of the country is completed and the database is getting ready. Similarly geophysical mapping both gravity and magnetic is also in the advanced stage. As the NGCM mapping advances integration of data generated in all these themes (Geological mapping, geophysical mapping and geochemical mapping) will be attempted which is expected to pinpoint potential target areas for further exploration. Similarly in the event of the alarmingly depleting state of our natural resources and where industrial growth of the country is in threat, a relook into the deposits, which were earlier declared as uneconomical, is warranted. Because of technological and scientific advancement over the last few years, the threshold value of many elements has been redefined and it has been the feeling that even smaller deposits also can be profitably mined.

