8 Geological Survey of India (GSI)

Introduction

8.1 The Geological Survey of India (GSI) was established in 1851 primarily with the objective of locating mineral resources including coal. In the 150 years since its inception, GSI has continued to grow and diversify into various geoscience activities, and has contributed immensely to Indian Geoscience. After independence, GSI's activities in mineral exploration as well as baseline surveys have increased manifold in order to sustain the momentum of national economic development.

GSI's activities may be grouped as 'Geoscientific baseline data' which includes geological surveys and mapping; 'Mineral Resource Assessments' which includes ferrous and nonferrous minerals, coal and lignite etc. 'Special Studies' which includes Natural hazards studies, Climatic studies, Geotechnical studies etc, and 'Geoinformatics' which include publication of Maps and Reports and generation of spatial information through GIS and related software for a variety of applications in developmental and regulatory situation as well in the commercial sphere.

Under the National Mineral Policy (NMP) 2008, Geological Survey of India remains the principal agency for geological mapping and regional mineral resources assessment of the country. The NMP seeks to ensure that GSI programmes are prioritized in line with the national policy goals and are chalked out after taking into account the exploration work undertaken by the private sector for which the existing arrangement of programme formulation through the Central Geological Programming Board (CGPB) would be revamped.

NMP envisages strengthening the Geological Survey of India with manpower, equipment and upgraded skill sets.

Thrust Areas of Activity

8.2 The thrust areas of GSI's activities have evolved with changing national priorities throughout successive Five Year Plans and are presently oriented in the light of the objectives and goals set for it in the XI Plan. The major thrust areas identified for GSI in the XI Plan are:

- Creation and updation of national geoscientific information and knowledge base through ground, marine and airborne surveys, with concept oriented thematic geological mapping on progressively larger scales and geochemical and geophysical mapping.
- Identification as well as preliminary assessment of the mineral resources.
- Geoscientific input to water resource development, transport and miscellaneous civil engineering projects.
- Natural hazard studies and disaster management including earthquake and landslide zonation studies.
- Shallow Subsurface Geology
- Geo-environmental investigations for both regional and site specific studies.
- Computerised archival, analyses, retrieval of geoscientific data and creation of theme-based relational databases.
- Dissemination of data through maps, publications, customization, intranet/extranet facilities through GSI portal etc.
- Training in specialised fields for upgradation of technology and expertise.
- Modernisation and expansion of laboratories and survey facilities.

Central Geological Programming Board

8.3 The Government set up the Central Geological Programming Board (CGPB) by Government Resolution

in 1966 for formulation and implementation of the programmes in the earth- science area, with close coordination between GSI and State Geological Departments and other central agencies. CGPB is supported by State level programming Boards and various subcommittees formed for the development of various mineral and geoscience based issues. While finalizing the programmes of GSI, the Government policies and directives, suggestions and recommendations of Five Year Plan document, Sub-committees of the Central Geological Programming Board and State Geological Programming Boards are considered.

The Central Geological Programming Board (CGPB) was revamped on 12th March, 2009 with three broad objectives viz., i) to effectively coordinate the different earth science related activities in the country, ii) to create geoscientific partnership through collaboration with various earth science organisations and State Agencies and iii) to create a modern data dissemination mechanism through its Web Portal.

In accordance with the reconstitution, 12 Committees for the various sub-sectors support CGPB and meet at least twice a year, to submit recommendations to the Central Board in respect of the respective sub-sector. During 2009-10 the 12 newly constituted Committees of CGPB met for the first time and deliberated on relevant issues concerning the development of natural resource before the 45th CGPB meeting held in September 2009. The second meeting of the Committees took place in November – December 2009 before the 46th CGPB meeting in February 2010. An important aspect of revamping was to energize the State Geological Programming Boards (SGPB) and 19 States have convened SGPB meetings during the year.

Restructuring of GSI

8.4 A High Powered Committee (HPC) was set up in January 2008 to thoroughly review the functioning of Geological Survey of India and assess its capacity to meet the emerging challenges. The Committee submitted its report on 31st March 2009 and the recommendation have been accepted by the Government. The organizational structure, recommended by the HPC Committee and accepted by Government, is under implementation and is given in the **Figuress 8.1** & **8.2**. The strength / incumbency in Group 'A' post in various streams is given in **Table 8.1**

Table 8.1

Statement Showing Strength / Incumbency In Group 'A' Posts in Various Streams in Geological Survey of India (as on 1.1.2010)

Stream	JTS		STS		JAG		SG		SAG		HAG		Total
	S	F	S	F	S	F	S	F	S	F	S	F	
Geology	1304	310	751	551	314	290	164	147	30	26	3	2	3892
Geophysics	237	113	118	35	51	18	26	19	4	4			625
Chemistry	234	107	61	23	30	17	14	12	3	3			504
Engineering	38	23	32	23	17	6	7	5	2	2	1	1	157
Personnel/ Administration	28	19	12	10	6	3	2	2	1	1			84
Finance			4	1	1	1			1	-			8
Stores			7	6	1	1	1	1					17
Library			1	-									1
Survey	2	-											2
Civil Engineering					1	-							1
Official Language			1	1									2
Law Officer	1	-											1
Vigilance			1	-	1	1							3
Total	**1844**	**572**	**988**	**650**	**422**	**336**	***214**	***186**	**41**	**36**	**4**	**3**	**4896**

Figure 8.1
Geological Survery of India - Missions

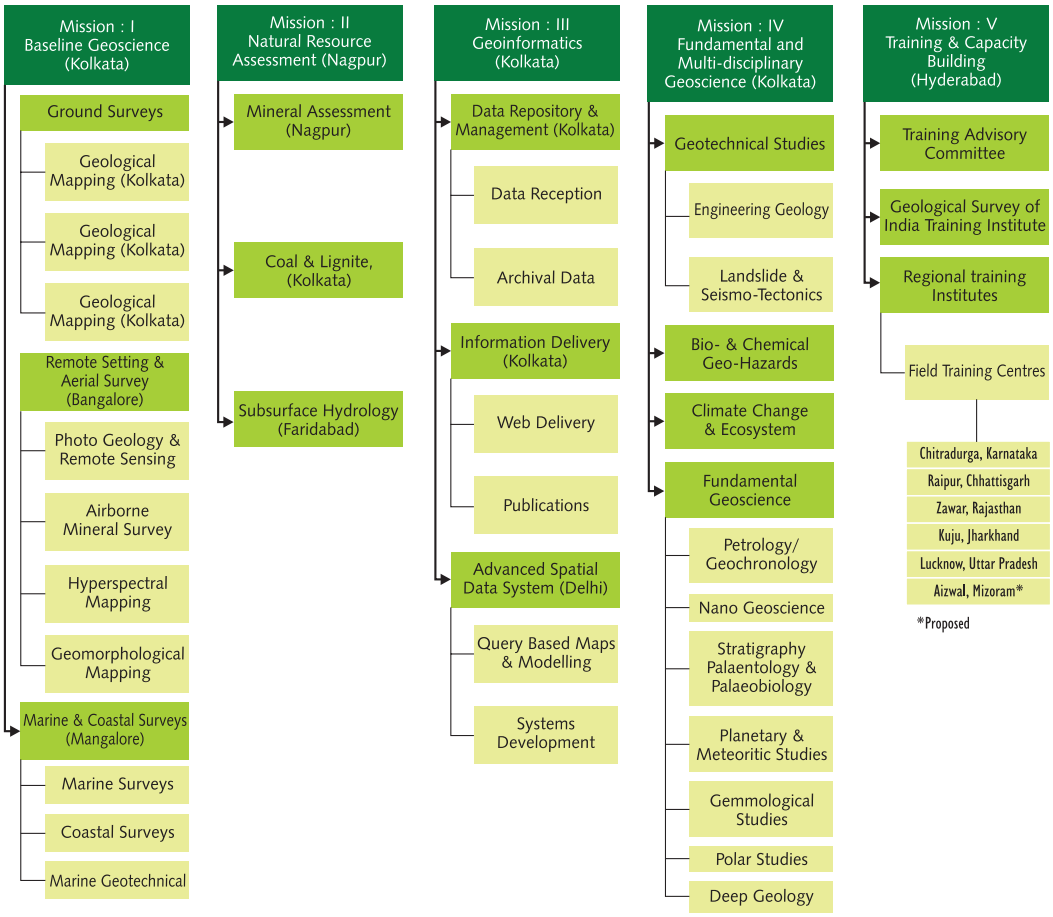
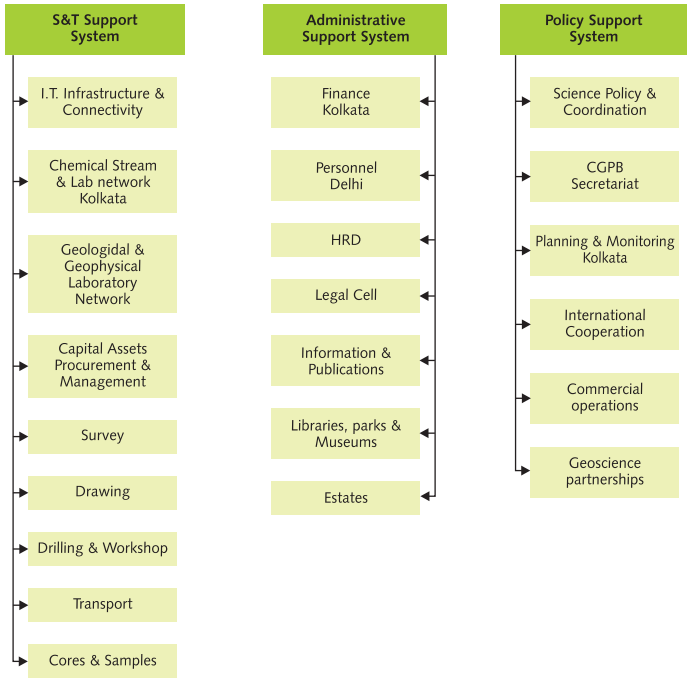
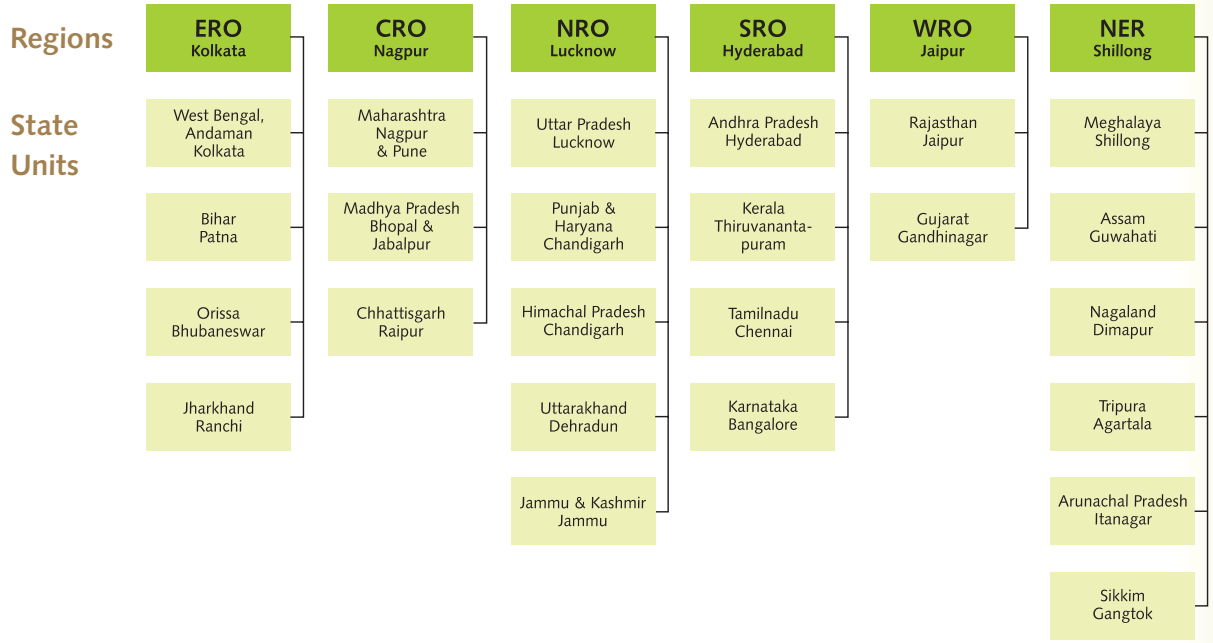


Figure 8.2
Organogram: Support Systems



The Director General (DG) as the operational head of the GSI has the overall responsibility of planning and execution of programmes of the organization. The DG, GSI is supported by Additional Director General (ADG) / Dy. Director Generals (DDG), in-charge of Missions and Support Systems. There are six Regions (geographically based) for programme execution and Additional Director General/Deputy Director General (HAG/SAG level) head each of these Regions and function as "Head of Department" (HOD) to oversee the formulation and implementation of annual programmes, exercise budgetary control, allocate resources, determine the relative priorities, and effect executive and other controls on Divisions/Projects within the Regions/Wings. Each Region has a headquarters unit for planning, finance and administration. Operational units at State level, headed by a Deputy Director General, execute the programmes in the field.

GSI has its Central Headquarters in Kolkata and six Regional offices (geographically based) at Kolkata, Shillong, Lucknow, Jaipur, Nagpur and Hyderabad and has State Units in almost all States as given below:



As recommended by the High Powered Committee, Geological Survey of India's status was upgraded on 14th July, 2009 and it is now formally an Attached office of the Ministry of Mines.

Status of Implementation of HPC Report

8.5 An Implementation Committee has been set up to go into the details for implementation of the HPC report and for further follow up of its 74 main recommendations. The following is the status of implementation of some of the main recommendations:

- GSI has switched over to the Mission- Region mode and the Field Season 2009-10 starting from 1.10.2009 is being conducted in this Mode.
- 'Mission Offices' have started functioning. Support Systems are being revamped.
- For implementation of Enterprise Portal Project in GSI, a Monitoring Committee under the Chairmanship of Additional Secretary (Mines) was constituted on 2nd April, 2009 and progress of the Portal Project work is being closely monitored. Completion Report of Phase I and Phase II is awaited. GSI is planning for Phase III in collaboration with National Informatics Centre (NIC).

- Central Geological Programming Board (CGPB) and its Committees have been revamped and a new CGPB Secretariat has already started functioning from Delhi.
- The Ministry of Mines has issued orders on 5.6.2009 for dissemination of Geoscientific information gathered by GSI for use by public at large for free of cost. GSI has drawn an action plan for digitizing and uploading all information legacy and larger scale maps.
- A Note for right sizing of GSI as per HPC Report circulated to all concerned Ministries for comments before being submitted for Cabinet approval.
- Training Policy Coordination Committee (TPCC) has been set up under the chairmanship of Secretary [Mines] to improve Training capabilities and set up Regional Training Institutes. GSI has started imparting training to officials of the State Governments in GSI's Training Institutes free of charge as recommended by the HPC.
- A New Transfer Policy was approved for GSI with effect from 01.01.2010.

Modernisation

8.6 As part of the effort to meet emerging challenges GSI is constantly upgrading its technology both for field as well as laboratory equipment.

The current status on procurement of the important capital assets is as under:

- Procurement of a new ocean going research vessel in replacement of GSI's existing Research Vessel Samudra Manthan at a cost of Rs.448.00 crores is underway.
- Procurement of a Heliborne Geophysical Survey System for GSI at a cost of Rs.52.00 crores is almost complete. The integration of sensors with the helicopter is to begin from March, 2010 with trial flights and to be completed by May, 2012 for all the four sensors. [Eleven Officers of GSI were trained on G-1A Gravimeter in Toronto, Canada in the month of August, 2009]
- Proposal for acquisition of a new Geotechnical Vessel with shallow drilling capacity for GSI at a revised cost of Rs.70.20 crores has been finalized and procurement action initiated.
- Laboratory and IT equipment: In addition, GSI as part of Modernisation has been purchasing laboratory and field equipment. A Modernization Committee was set up in 2001 which made many significant recommendations in this regard and the recommendations have been substantially implemented except in respect of the following:-

  (i) Palmtop computer, Digital camera and Cellular phone for each field officer

  (ii) Magnetic Gradiometry

  (iii) Gamma ray Spectrometry

  (iv) Penetrometers

  (v) Transient EM sounding and profiling etc.

A new Modernisation Committee has been constituted on 30th June, 2009 to make further recommendations keeping in view the HPC Report.

Performance of GSI during 2009-2010 at a glance

8.7 The Scheme wise and percentage wise Plan expenditure for the first three years of the XI Plan (till December 2009) is given in **Annexure 8.1**. Target vs. Achievement during the first three years (2007-10) of XI Plan (2007-12) of the Geological Survey of India is given in **Annexure 8.2**.

8.8 GSI has annual Field Season Programmes for various surveys and field investigations. After the completion of the field duty and the subsequent laboratory work, the field party submits its report as a Progress Report. If a particular field item demands continuation of the same field assignment for further survey and rock analysis, the field item is continued and an Interim Report is submitted especially in the

case of Geochemical mapping, exploration for minerals, etc. On completion of the full assignment including laboratory studies, a Final Report is submitted which marks the culmination of all geoscience activity on a particular project/item. During the F.Y 2009-10 (upto December 2009) a total of 432 nos. of reports were finalized and circulated. Lists of number of pending progress in the categories of Progress Report, Interim Report and Final Report in respect of geological (including mineral investigations) and geochemical surveys/investigations are given in **Annexure 8.3 and 8.4**.

MISSION I: BASELINE GEOSCIENCE DATA GENERATION

8.9 The Mission wise detailed programme are given in the follow up paragraphs:

Systematic Geological Mapping

8.10 Systematic Geological Mapping on 1:50,000 scale, the most fundamental mapping programme, adopted by GSI in past decades generated the basic data stream which catered to our National Geoscientific Information and knowledge base. Out of the 3.146 million sq. km mappable area, 3.09263 million sq. km have so far been covered by systematic mapping, bringing the total coverage to 98.3%. An area of 130 sq. km has been covered by Systematic Geological Mapping in Mokokchung, Longleng and Tuensang districts of Nagaland during 2009-10.

Groove sampling of Metagabbro for PGE find

Specialised Thematic Mapping (STM)

8.11 GSI has launched specialized theme oriented large-scale (1:25,000 or larger) studies/mapping items (Specialised Thematic Mapping) from VIII Plan period. The studies involve application of multidisciplinary techniques, often complemented by precision laboratory studies. The outcome of these mapping efforts have already proven its importance in the areas of prognostication of natural resources, environmental analysis, natural hazard recognition and risk management, land use management, evaluation of major civil engineering projects etc. An area of 3174 sq.km has been covered by STM (during the year upto December 2009) raising the total coverage to 1,40,823.50 sq. km.

Geophysical mapping

8.12 Systematic ground gravity - magnetic surveys under the Geophysical Mapping Programme (GPM) has been initiated during X Plan Period and is being continued in XI Plan Period. The mapping process involves acquisition of gravity and magnetic data with an average station density of one station per 2.5 sq km area for compilation of standardized gravity and magnetic maps of the country on 1:50,000 scale. A total of 11 investigations were taken up by different Regions under the GPM programme during the year raising the total coverage to 1,26,663.30 sq. km.

Geochemical mapping

8.13 India's National GeoChemical Mapping (NGCM) Programme was initiated by GSI in 2001-02 with the launching of a number of pilot surveys in different States all over the country. The prime objective of this endeavour is to produce a body of geochemical data on 1:50,000 scale for the Indian landmass based primarily on stream sediments, analyzed using standardized set of methods. These data will compose a complete, national-scale geochemical coverage of the Indian land area, and will enable construction of geochemical maps, refine estimates of baseline concentrations of chemical elements in the sampled media, and provide context for a wide variety of studies

in the geological and environmental sciences. The extent of landmass of the country covered with hard rock, soft rock and alluvial tracks is 3.28 million sq. km corresponding to 5065 toposheets. About 1,66,006 sq km area encompassing 227 toposheets has been covered systematically under NGCM till date. An area of about 839 sq km is covered (up to December 2009). Geochemical Mapping especially in the mineral prognosticated areas will be continued. A National GCM database is being created centrally with the intention of producing maps depicting geochemical anomalies requiring detailed investigation for various purposes including mineral investigation.

Airborne Mineral Survey

8.14 Airborne Geophysical Surveys are carried out by the Twin Otter Airborne Survey System (TOASS) with Magnetic and Gamma Ray Spectrometric Sensors acquired by GSI in 1986. Since then (upto December, 2009) a total of 4,76,162 line km over an area of 2,55,065 sq.km. was covered by deploying multi sensor systems.

Aerogeophysical survey was carried out using multi sensors over 24,101 line km (12,857 line km in Kanker area, Bastar Craton, Chhattisgarh; 11,244 line km in Mauranipur-Sarila, M.P. – U.P. border area) covering an area of 12050 sq km (6,428 sq.km. in Kanker area and 5,622 sq.km in Mauranipur-Sarila area) during the Field Season 2008 – 09.

As part of the modernization programme, GSI has recently procured one helicopter with state-of-the-art TM domain, EM system fitted on a heliborne platform along with the latest magnetic, spectrometric and gravity heliborne geophysical survey systems.

Marine and Coastal Surveys

8.15 Geological Survey of India carried out offshore geoscientific studies both in Exclusive Economic Zone (EEZ) and Territorial Waters (TW) along the East and West Coasts of India. Five cruises were mounted onboard RV Samudra Manthan within EEZ. Six cruises were launched onboard RV Samudra Kaustubh within TW off the East Coast of India. Seven cruises onboard RV Samudra Shaudhikama were carried out within TW off the West Coast of India. Surveys in the near shore zone (0 to 10m isobath) are carried out using hired small-mechanized boats.

Geological Survey of India has completed seabed mapping of 19,75,364 sq km out of a total of 20,14,900 sq. km within EEZ including TW and 1,27,046 Sq. km out of 1,50,000 Sq. km of TW till 2008-09. Beyond TW, coverage of EEZ is 18, 48,318 sq km till FS 2008-09. During the Field Session (FS) 2008-09, swath bathymetry of 76,229 sq. km., 12,792 Lkm of bathymetry, 15,782 Lkm of magnetic parametric surveys were done within EEZ and 3105 sq. km. mapping was carried out within Territorial Waters along with 377 sq. km. of swath bathymetry, 1,605 Lkm of bathymetry, 114 Lkm of magnetic and 1,396 Lkm of shallow seismic parametric surveys.

MISSION: II NATURAL RESOURCE ASSESSMENT

8.16 The Geological Survey of India (GSI) is vested with the responsibility of maintaining broad based and uniform national approach to data generation in respect of mineral resources to cater to the demand of the nation for providing reliable information on mineral and other natural resources to the public and private entrepreneurs. Systematic updating of the database of the survey in the mineral sector is being continued. From Field Season 2009-10, the resource evaluation will be made totally under UNFC three digit code system (economic, feasibility and geological axes) in accordance with the requirement of the National Mineral Policy 2008.

For the Field Season 2009-10, a total of 92 items (excluding three offshore mineral investigations) are included, of which 69 are under 'Mineral resource assessment' (ores and minerals) and 23 belong to 'Natural energy resources' i.e. [coal and lignite].

Among these 69 projects under Mineral Resource Assessment, 11 are for Ferrous Minerals (Iron, Manganese, Chromite), 22 for Precious Metals & Minerals (12 for Gold, 7 for PGE, 3 for Diamond), 24 for Non-Ferrous and Strategic Minerals (21 Base metal,

3 Molybdenum) and 12 for Industrial & Fertilizer Minerals.

The programming of energy resources [coal and lignite] has been designed in tune with the XI Plan proposal approved by the Planning Commission, Government guidelines issued from time to time and the recommendation of the CGPB Committee Group V (Energy Minerals). Planning and finalization was based keeping in view the key factors i.e., (i) locating power grade coal at shallow depth, (ii) proving of superior quality including coking coal, (iii) identifying new areas in deeper unexplored part of the basins or as an extension of explored blocks/existing mines, (iv) establishing additional resources of lignite from power hungry southern and western states and (v) assessment of CBM potentiality in green field areas of selected coal/lignite basins. GSI has formulated a total of 23 coal – lignite exploration items, out of which 19 items fall in CIL, 1 item in SCCL and 3 items in Lignite bearing areas (out of 23, 10 nos. are of promotional nature).

Out of these 69 mineral investigations, 18 investigations (excluding two of Kerala on sand in offshore and onshore) are through State requests/ collaborations.

Mineral search and assessment is undertaken with special emphasis on deficient commodity of high value (e.g. gold, diamond, PGE etc.), strategic minerals (molybdenum, tungsten), fertilizer mineral (phosphorite and potash) as well as ores and minerals of high demand (basemetal, ferrous minerals, coal, lignite, limestone etc.). A total of 568.75 sq. km. large scale mapping, 19.725 sq.km. detailed mapping and 43,004.44 m drilling were done under Mission II (upto December '09).

Mineral Resource Assessment

8.17 Some of the important findings under Mineral Resource Assessment during the year FS 2008-09 are enumerated below:

Iron Ore

- Exploration for iron ore in Ghoraburhani-Sagasahi area, Sundargarh district Orissa, indicates that the total strike length of the iron ore body is about 1.95 km with a surface width varying from 40m to 250m. Based on the analytical results the iron ore resource has been estimated at 9.1million tonnes at 55% Fe cut off.

Manganese

- Exploration for manganese in Bolani block, Orissa resulted in re-estimation of the resource to 0.66mt at 20% Mn cut off with an average grade of 25.52% Mn corresponding mostly to G-2 stage of exploration in UNFC system. Thus 0.01 million tonne has been added to resources. Damurda Block of Bonai-Kendujhar Belt, Kendujhar district, Orissa has been explored and a tentative resource from northern part of Damurda (North) block has been estimated at 0.94million tonnes at 20% Mn cut-off.

Basemetal

- A low grade copper mineralized zone has been established for a strike length of 600m (0.35% Cu X 13.83m) and for 400m (0.18% Cu X 6.25m) at two different sectors at Gangutana, Mahendragarh district, Haryana. A resource of 2.128 million tonnes at 0.4% Cu have been estimated over a strike length of 800m and vertical depth of 100m towards north of Gangutana. The stage of exploration corresponds to UNFC system-G3.

Strategic Minerals

- In Tamil Nadu a concept-oriented exploration for molybdenum was taken up in Velampatti South Block, Harur-Uttangarai Belt, Dharmapuri district to test the strike extension, depth persistence and potentials of the hitherto unexplored footwall shear zone. With the help of three boreholes, it has been interpreted that a number of molybdenum bearing quartz veins are confined to a zone of shearing and are much wider than conceived earlier. Investigation will be continued during F.S. 2009-10 to establish the geometry of the deep level shear zone, its relation with the

shallow level shear zone and the geometry of the lodes within the shear zone.

Gold

- Bedrock samples in Ajjanahalli Block-C, Tumkur district, Karnataka yielded gold value ranging from 0.10 g/t to 4.22 g/t. Analysis of trench samples indicated gold value ranging from 0.36 g/t to 6.0 g/t. In Ajjanahalli block-F, three major auriferous BIF bands have been delineated. Band-I (strike length 300m average width 3 to 4m) has recorded 1.02 to 2.2 g/t gold; Band-II (strike length 200m average width of 2m) has recorded 0.28 to 1.70 g/t gold; Band III (strike length of 700m average width 4m) has recorded gold values from 0.03 to 0.70g/t.
- On the basis of analytical result a resource of 22.97million tonnes of gold ore with 1.81 g/t Au has been estimated in Delwara West block, Rajasthan. The total gold resource of Bhukia gold prospect has been augmented from 60.58million tonnes to 83.55 million tonnes with an average grade of 1.87g/t Au. The stage of exploration corresponds to G-3 of UNFC system.
- A tentative resource of 0.053 million tonnes gold ore with an average grade of 3.03 g/t Au has been estimated in the Proterozoic rocks of Sonapahari area, Sonbhadra district, Uttar Pradesh. The stage of exploration corresponds to G-3 of UNFC system.
- Investigation for gold mineralization in Sonadehi gold prospect Chhattisgarh, revealed a resource of 2.28 million tonnes with 0.699 g/t gold. The stage of exploration corresponds to G-3 of UNFC system.

Diamond

- Search for kimberlite in Buthpur and Achampet block in Mahbubnagar district, Andhra Pradesh, yielded kimberlite specific minerals like picro-ilmenite and chrome-spinel in stream sediment samples from Palkampally, Wattipalli and Kottapalli. Kimberlite specific minerals like chrome spinel has also been recorded from Kalwakurthi and Charakunda block in Mahbubnagar and Nalgonda districts.

Platinoid Group of Elements (PGE)

- In Mettupalaiyam Ultramafic Complex, Tamil Nadu the average width and grade of the PGE bearing zone is 3.50m with Pt value ranging from 42 to 601 ppb and Pd from 92 to 1575 ppb. A mineralized zone with high value of PGE (277 ppb Pt and 698 ppb Pd) has been traced for about 100m in Mallanayakapuram area.
- In Chettiampalaiyam block of Sittampundi Layered Complex, Tamil Nadu PGE mineralization with average grade of 0.91 ppm Pt + 0.77ppm Pd (for a width of 1.55m) and 1.76 ppm Pt + 1.72ppm Pd (for a width of 1.80m) was recorded. PGE mineralized zone with 1.62 ppm Pt + 0.31ppm Pd was traced for 300m.
- In Maharashtra, samples of pyroxenite from Heti area have analyzed 35-95 ppb Pd, 11-78 ppb Pt.

Fertiliser Minerals

- In West Bengal an investigation for apatite and associated minerals was taken up in Panrkidih and Cholwari area, Purulia district during the F.S. 2008-09. In Belaidih block, a 130m strike length of the mineralized body has been established with over 20% P_2O_5. In Chholari block two isolated patches of mineralized body were recorded at 300m apart.

Limestone

- In Rajasthan, exploration for limestone was taken up in Minyun Ki Dhani block, Jaisalmer district. The boreholes intersected hard and massive SMS-grade limestone bands belonging to Khuiala Formation (Eocene/ Tertiary) whose thickness ranges between 0.24m and 7.50m.

Natural Energy Resources

Coal & Lignite

8.18 An additional resource of 1638.52 million tonnes of coal and 0.19 million tonne of lignite has been

assessed from the data generated from regional exploration by GSI. The geological resources of Coal of the country stand at 267.21 billion tonnes and that of lignite at 39.07 billion tonnes as on 01.04.2009.

Coal Bed Methane

CBM study for determination of in-situ gas content has been carried out under promotional scheme in seven boreholes (Rajmahal, Birbhum, Ramkola-Tatapani, Talchir, Sohagpur Coalfields and Tamil Nadu Lignite Fields) and is presently continuing in two boreholes in Birbhum and Mand-Raigarh coalfields. Gas desorption studies show very incipient gas content (<1.0cc/gm) in all the Coal/Lignite fields except Sohagpur Coafield (around 2.0cc/gm), which may be attributed to higher thermal maturity of the coal. The adsorption studies conducted so far (Rajmahal, Ramkola-Tatapani coalfields and Tamil Nadu Lignite Field) indicate that the seams are highly undersaturated in methane.

MISSION: III GEOINFORMATICS

GSI Portal Project

8.19 Geoscientific database building activity in GSI has gained a new impetus with the implementation of Enterprise GIS, which is a significant part of the GSI Portal Project. Enterprise GIS envisages a centralized repository (spatial data warehouse - SDW) of unified and coordinated spatial data resources providing secured, authorized access to all users. Enterprise GIS components such as Load & Update system, Inquiry system are implemented.

Phase – I&II

The GSI Portal project will have two active components – (i) Building a Network infrastructure, connecting different offices of Geological Survey of India, which include Central Headquarters, Regional Headquarters, Wings and Operation Units & creating a LAN and WAN, and (ii) creation of a portal capable of hosting corporate data, disseminate public domain data to common mass, support e-business and promote e-learning. Both the components of the Project are to be implemented concurrently with simultaneous creation of databases for administrative and scientific domains. The network will facilitate i) Faster interaction among the earth scientists for sharing of knowledge and experience for effective and timely solution of various problems and ii) Initiation of web-centric database for concurrent input and output of data in customized formats at a faster rate, which will be available to users as per their need and authentication. The SFC on "The proposal of Network & Portal in Geological Survey of India" was held on 11.08.03. The project was to be completed in two Phases. Phase-I was to be completed by March 2004 at a total cost of Rs.12.2 crores and Phase-II to be completed by March 2005 at a total cost of Rs.12.80 crores.

Phase – III: Future Plans

GSI aims to enhance access to and delivery of services to benefit the public in general, and the stakeholders in particular. More importantly, it aims to help strengthen government's drive toward effective governance and increased transparency to better manage the country's natural resources for development. The next step would be to enhance the access to and delivery of services and information to benefit the public (G2C), other government agencies (G2G), business partners (G2B) and employees (G2E). GSI with its large volume of data encompassing more than 30000 unpublished reports (largely text information with tabular data, maps, images and diagrams), over 750 publications, published maps and numerous other documents which gets generated everyday through regular office processes intends to use a system which would enable it to electronically store, archive, organize, index and file documents, such that they can be retrieved anytime, anywhere, without any loss of time.

Data accretion and publication on Portal

8.20 Documents (both text and graphic) generated and circulated by GSI are basically of two types: (a) printed and published material for sale as well as for free

distribution and (b) unpublished documents for circulation within GSI and also for sale after costing on case to case basis for bonafide users. The Policy in this regard has been modified under direction of the Ministry on 5.6.2009 and will henceforth be as given in **Annexure 8.5**.

8.21 Geological maps on 1:50K scale were compiled at regional level and with an objective to prepare seamless geological map of India. The digitized geological layer of 1:50K maps are being uploaded in the Portal. A total of 3065 maps on 1 : 50K scale have been uploaded in the portal till December, 2009. Out of 334 sheets of Geological Quadrangle Maps amenable to compilation and dissemination, 292 have been published till date. Geological and Mineral Map of States (Scale 1:2M), describing the geology and mineral resources of 30 different states of India Regions are updated regularly. The Geological and Mineral Map of Assam and Geological and Mineral Map of Meghalaya were scrutinized for updation. Spatial database with relevant attribute information have been built during the period with an aim to add two new layers for the existing 1:2 M map service. These include information on meteorites fall in Indian sub-continent and age data of the Indian rocks. Seven District Resource Maps of Eastern Region and one map of Southern Region have been published during the period. Compilation of geological and geophysical data on a Territorial Water map of Bay of Bengal has been taken up. In view of the growing demand of users in the fields of urban planning, water resource development, environmental hazard and neotectonic studies, compilation of Quaternary Geological Atlas of India was taken up in 2003 and is continuing. About 802 nos. of various published geological maps uploaded in Portal.

8.22 The uploading of Legacy Field Season Programme data and extended abstract of the programmes completed till date since 1986 was initiated in July 2009 and till date about 5046 items have been put in the GSI portal for public viewing.

8.23 The metadata of about 30,880 nos. of reports of GSI have been uploaded, and 1069 nos. of full reports published after 2004 have been accommodated in the GSI Portal for consultation and downloading as per the new dissemination policy of the Government. Besides above, the portal is populated with large number of case studies, DIDs and photographs of general interest.

8.24 The all India earthquake database is being updated incorporating 6111 events of 2005 from ISC bulletin. A total of 28278 events occurring within the territory covered by latitude 0°-37°N and longitude 68°-98°E have been incorporated in the database.

Laboratory data:

8.25 Vast volume of data is being generated by analysis of samples collected through National Geochemical Mapping programme. A step has been taken to systematically archive this voluminous geochemical data. Accordingly, toposheet-wise database is being built on database compatible format which will be integrated with GSI Portal in due course.

On line Library

8.26 As a part of GSI Portal, LIBSYS - the web-compatible network version of Library Management software - started functioning. Up to July, 2009, 234 publication related data could be entered. Database on 800 GSI publications have been edited and 409 of these have been entered into TEXTO software towards metadata preparation for soft copy conversion of GSI publications. Metadata of 3022 articles from 326 volumes including 185 parts, have been compiled. 175 International Maps have been scanned for soft copy conversion.

Creation of Geophysical data repository

8.27 Creation of geophysical data repository involves designing and development of data format, data standard, data dissemination, data storage, data processing and development of data delivery products like digital data, digital maps on different scales and dissemination of various technical reports together with in-house expertise. The in-house work has been

initiated for developing standards, formats etc. Procurement of computer hardware like server, network and development of customized software for data inputs, data manipulation and delivery of data products for which actions have been initiated.

MISSION: IV FUNDAMENTAL AND MULTIDISCIPLINARY GEOSCIENCES AND SPECIAL STUDIES

8.28 An additional amount of Rs. 15.00 crores was announced in the budget, 2009-10 :

Three projects have been identified which are mentioned below:-

1. Geomorphological Mapping on 1:50000 scale– GSI along with Indian Space Research Organisation (ISRO) has taken up Geomorphological mapping of the entire country on 1: 50K scale using Remote Sensing Techniques and limited field checks. The project is to be completed by 2012. Expenditure incurred on these items in F.Y. 2009-10 is of the order of Rs. 10.66 lakhs.

2. 1:50000 scale Map Service on Internet – GSI in collaboration with National Informatics Center is exploring the prospects of using open source software and open GIS platform for creating map service on internet. GSI has initiated finalization of geological map layer in National Grid and uploading with attribute data in geodata base for intranet viewing and has uploaded around about 2000 toposheets as a back-end support. An expenditure of Rs. 18.51 lakhs has been incurred on it in F.Y. 2009-10.

3. Creation of Geophysical Data Repository and acquisition of geophysical sensors – GSI has initiated in-house work for developing standards, formats, etc. It feels that services of a consultant is required for identifying the need for procurement of computer hardware like server, network and development of customized software for data inputs, data manipulation and delivery of data products. Procurement action for geophysical sensors has been initiated by GSI. The expenditure incurred on this item in F.Y. 2009-10 is of the order of 487.22 lakhs.

Geotechnical Investigations

- Thirty three items of geotechnical and engineering geological studies through 190 investigations were undertaken related to civil engineering projects for water resource development, communication and miscellaneous projects in almost all the states of the country as well as in neighboring countries

Seismic/Earthquake Geology

- Five items of active fault mapping and three items of seismic microzonation were undertaken in addition to other earthquake related studies.
- The Seismic observatories of GSI in Jabalpur, Nagpur etc are continuously recording global, regional and local seismic events and monthly / quarterly data has been published and distributed regularly.
- The permanent GPS station at Lucknow (established by DST) is engaged in round the clock monitoring of GPS data. The data was supplied regularly to National GPS Data Centre, Survey of India, Dehradun for further processing/ interpretation.

Landslide Hazard Studies

- Geological Survey of India has been declared as the Nodal Agency for Landslide Investigation in the country and to develop a comprehensive strategy for the effective mitigation of Landslide Hazards in landslide prone areas. A new guideline released by Government of India lays emphasis on preparedness, capacity building and awareness generation. This guideline will be implemented through a Detailed Project Report (DPR), which is under preparation.
- GSI has undertaken 20 programmes of landslide investigation in the landslide prone hilly terrain.

A total of 2,195 sq km by Landslide Hazard Zonation and 572 Line kilometer road corridors have been covered on Macro Scale (1:25,000/ 50.000) during F.S. 2008 - 09.

- Eleven townships have been covered by Landslide Hazard Zonation on Meso Scale (1:5000/10,000) to assess the stability status of the existing thickly populated townships/important civil engineering structure etc. in the landslide prone hilly terrain.

- Landslide Inventory has been taken up for all old and fresh landslides for their documentation throughout the country. Detailed site-specific studies of three landslides have been carried out.

Environment Geology

- Regional Geoenvironmental impact assessment of limestone mines and cement plants in Chittorgarh; Sirohi, Pali, Jodhpur and Nagaur districts, Rajasthan and formulation of effective environmental management plans, Geoenvironmental appraisal in parts of Sohagpur Coalfied, Annupur and Shahdol Districts, MP - Surguja District, Chhattisgarh and Geo-environmental impact on rapid urbanization of Berhampore – Murshidabad townships and their environs in West Bengal were taken up.

Medical Geology (Bio- & Chemical Geohazards)

- Study of incidence of arsenic in groundwater in parts of Saran and Vaishali districts, Bihar reveals that the older alluvium surface appears to be free from hazardous incidence of arsenic in groundwater while the younger alluvium (older/ present flood plain) show hazardous incidence of As ranging from 50 ppb to >500 ppb in ground water with reports of varied forms of skin diseases in local population.

- Development of a mitigation strategy to manage risk from arsenic toxicity in groundwater of West Bengal, India was continued in collaboration with NR-Can, Geological Survey of Canada.

Glaciological Studies

- Glacio-geomorphological mapping covering an area of 0.50 sq km has been undertaken on the both the banks of melt water stream of the Hamtah glacier, Lahul – Spiti district, H.P. Monitoring of glacier snout on 1:5000 scale has shown that the glacier has vacated an area of 0.006 km^2 since 2007. During the last eight years 2000 – 08, the glacier has vacated an area of 0.0346 km^2 with an average being 0.0043 km^2/ year.

Antarctic Studies

- GSI has been continuing with its Antarctic studies programme and till date more than 19000 sq km area has been mapped with the help of ground traverses. During the 28th expedition (2008-09) two geologists of GSI have mapped around 250 sq km area in the Gjelsvikfjella region using the Norwegian station TROLL as base.

- Monitoring of the snout of "Dakshin Gangotri Glacier" overriding the southern edge of Schirmacher Oasis has shown a consistent recession (1.09 m during 2008-2009) which has been partly attributed to changes in the global climate pattern. During the same period the drift snow accumulation over the shelf has been recorded as 89.5 cm. GSI started drilling for retrieving ice cores to study the palaeoclimate of

GSI Field team at Antarctica

the area and embarked on the study of sediments from the lake bottoms of Antarctic lakes and GPR studies to draw profiles of lakes as well as to determine the ice-land-ice-sea interface. Using MLF antenna of 35 MHz frequency, a depth of up to 400 m has been reached in profiling.

- India's third research station has been planned to be established at Larsemann Hills region, Prydz Bay area of East Antarctica. GSI started mapping of the new site and a geological map has been prepared for a portion of the area around the new station site.

Arctic Studies

- To continue the studies carried out in previous expeditions, the Third Arctic Expedition launched from 16th June 2009 to 18th July 2009. In view of the heavy snow cover on Vestre Broggerbreen glacier, and several melt water channels in the proglacial region, glacier remained unapproachable. Field work was restricted to density profiling of snow cover sections and geomorphological mapping in the proglacial region using handheld GPS. Mapping of the snout of glacier revealed marginal recession as compared to August 2008. During the period, five snow and melt water samples collected for trace elements. In addition, two samples were collected from terminal moraine –I and II for T.L./O.S.L. dating. The team also tested their ice-drilling machine using gasoline for fixation of stakes.

8.29 Laboratory Studies, Research and Development

- GSI laboratories have been upgraded with state-of-the-art instrumental facilities. Intensive laboratory studies are being carried out to generate precise analytical database to support the field investigations. Input from Electron Probe Micro Analyses, Fluid inclusion study, Optically Stimulated Luminescence (OSL) dating etc. has been widely and effectively used in different research projects.

- Basic petrological researches on crustal evolution, metallogeny, volcanism, evolution of sedimentary basins through time and space, experimental petrology, climatic change and responses of environment system, studies on geological health hazard and remedies etc are continued.

- The study of the geological and geomorphological determinants of the characteristics of present day beaches in Andaman Island for coastal management identified that both the sea and hinterland are the possible source of stress on the target beaches. The Betapur beach in Middle Andaman appears to be vulnerable in respect of effects of sea induced stress. Corbyn's Cove beach of South Andaman and Wandoor beach close to Port Blair are more susceptible to stress from hinterland due to man induced process.

- Palaeontological and palaeobiological studies for stratigraphic correlation and records of climate change revealed that there has been a three fold increase in low salinity indicator planktonic foraminifera suggesting increased monsoonal precipitation and increased runoff from Ganga-Brahmaputra river system diluting the salinity of surface layer water in the central Bay of Bengal.

- Precise dating of the geological samples has been undertaken at the Geochronology and Isotope Geology Division. Regression of strontium isotopic data of six whole rock samples of Chinnapendekallu granite, Andhra Pradesh yielded a Rb–Sr whole rock isochron age of 2364Ma.

- Radiocarbon dating of Shell samples from Gujarat revealed an age of 29,609 ± 320 Ybp.

The GSI research vessel RV Samudra Manthan in the Andaman sea; in the back ground is Barren Volcano

Museum:

The Indian Museum has four galleries dedicated to Geology namely: Siwalik Gallery, Earth & Meteorite Gallery, Rock & Mineral Gallery and the Invertebrate Fossil gallery since 1875. As a part of setting up of a state-of-the-art Earth & Meteorite Gallery, an initiative has been taken up to restore the antique showcases of the Indian Museum 200th anniversary (2014) Celebrations of the Museum.

- Provided information on earth science and of the department's activity Curatorial Division has put up 8 major Earth Science Exhibitions with preparation of pavilion model, planning of pavilion setup, ordering the displays, designing presentations etc. Audio visual presentations were also prepared through divisional resources and presented through LCD TV.
- A data base on the Fossil Repository is available online with 756 nos. of GSI collection along with modification of more than 250 old records.

MISSION: V TRAINING AND CAPACITY BUILDING

Training Policy Coordination Committee

8.30 The High Powered Committee recognized that training activity needs to be vastly expanded to cover all the stakeholders, organizations and recommended that in addition to the Training Advisory Committee of GSI, there should be a Training Policy Coordination Committee (TPCC) chaired by the Secretary (Mines). A Committee was formed to meet at least once a year to review training activities of Training Mission, approve policy and strategy initiatives. The Committee met for the first time on 10.9.2009 and again on 23.12.2009, and has been giving policy and strategic direction to GSI in revamping the training infrastructure.

Newly Recruited Geologist with Mr. Vijay Kumar, Special Secretary (Mines) near the Field Training Centre, Zawar (Rajasthan)

Human Resource Development

Since its inception in 1976, the GSITI has conducted 666 training programmes (up to 31st July, 2009) and trained 14,078 geoscientists of GSI, other earth science organizations and universities of the country and also geoscientists from ESCAP and SAARC countries. The training programmes are focused on fundamentals and applied aspects of geosciences viz. Geology, Geophysics, Chemistry, Mineral Investigation, Natural Hazards, Remote Sensing, Drilling and Surveying. The Institute regularly conducts DST (Department of Science & Technology) supported programmes, ISRO (Department of Space) supported Remote Sensing (NNRMS) programmes, customized courses for other agencies and administrative courses for the departmental personnel.

GSI Training Institute is providing high quality cutting edge training /knowledge with state-of-the-art facilities. The TI would conduct induction level Courses for GSI scientists, specialized courses, International courses and Training of Trainers (TOT) courses for Regional Training Centres and State Institutes. The Institute has embarked on programmes of capacity building in the field of geosciences to raise the technical ability of departmental candidates, students, research scholars, faculty from Universities and officers of various State Governments and private sector departments. GSITI conducted orientation course for geologists, 10 scientific courses, 6 technical courses, 11 administrative courses and 2 sponsored courses. Five programmes have been undertaken as outside FSP programme.

The HPC recommended creation of Regional Training Institutes (RTI), one each at the Regional Headquarters of Geological Survey of India except at Southern Region, (the training needs of Southern Region will be looked after by GSITI, Hyderabad), under GSITI to function in a hybrid matrix system of Administration.

Regional Training Institutes forming part of the Regions will have Field Training Centres (FTCs) specializing in a particular geologic domain. Accordingly, order was issued December, 2009 creating Regional Training Institutes as follows:

Sl. No.	Regional Training Institute	Specialisations
1	GSI Regional Training Institute – SR	Petrology, Remote sensing, Geoinformatics, Geophysics, Rock Mechanics, Geotechnical Studies
2	GSI Regional Training Institute – NR	Glaciology, Engineering Geology Himalayan Geology, Siwalik Mapping, Seismotectonics and Earthquake Engineering, Quaternary Geology, Landslide and Landslide Hazard studies, Active Fault Mapping
3	GSI Regional Training Institute – WR	Desert Geology, Exploration Techniques, Ore Deposit modeling & evaluation, Geochemical exploration, Archaean/ Proterozoic Terrain Mapping
4	GSI Regional Training Institute – CR	Deccan Traps, Drilling techniques, Geo-archaeological studies, Photogeology & Remote sensing studies, Medical Geology, Quaternary Geology, Geomorphology and landuse
5	GSI Regional Training Institute– ER	Sedimentary basin analysis, Gondwana Geology, Mapping techniques in Coal field areas, Coal exploration, Coal petrography, Coastal & near shore processes
6	GSI Regional Training Institute – NER	Mapping techniques for Tertiary rocks, Neotectonics, Landslide & Landslike Hazard studies, Geo-environmental & Fragile ecological studies

The Field Training Centres attached to the Regional Training Institutes (RTI) are as follows:

Sr.No	RTI	Field Training Centre	Specialization
1	RTI- SR Hyderabad	1) Chitradurga,2) Kothagudem*	Mapping in Igneous and Metamorphic terrain
2	RTI- NR, Lucknow	1) Bhimtal, 2) Saketi*	Himalayan Geology/Bio-stratigraphy/Paleontology
3	RTI- WR, Jaipur	Zawar	Mineral Exploration
4	RTI- CR, Nagpur	Raipur	PGRS /Administration
5	RTI- ER, Kolkata	Kuju,	Mapping in Sedimentary terrain /Coal Geology
6	RTI- NER, Shillong	Aizawl*	Landslide

* Proposed New FTC

S&T Support System

I.T. Infrastructure & Connectivity

8.31 GSI manages a countrywide robust IT infrastructure for rapid collection, documentation and effective dissemination of geoscientific data.

Infrastructure resource of GSI can be classified under the following broad heads;

- Local area network at different regions and operations
- Wide area networking connecting those LANs.
- Data center at Kolkata
- Disaster recovery center at Hyderabad

Local Area Network

Local Area Networks (LAN) at GSI is designed to provide a scalable, secure and stable network based on intelligent Ethernet switches. Important design parameters include high availability, Quality of Service (QoS) and network security. To achieve optimized network performance adequate for sustaining portal applications, three-layer hierarchical model has been adopted in CHQ and RHQs.

Wide Area Networking

Wide Area Network (WAN) at GSI joins 37 offices of GSI spread over different parts of India with Data Center at Kolkata and Disaster Recovery site at Hyderabad. The WAN with state-of-the-art TCP/IP based MPLS VPN technology is implemented over BSNL backbone. The links have variable bandwidth: CHQ and CAN at Kolkata 2 Mbps each, RHQs 1 Mbps each, Op Units 512, 256, 128 Kbps and very small offices 64 Kbps.

GSI WAN connectivity is established with MPLS link to the nearest BSNL POP using dedicated managed leased line link. The links are configured with static routing upto PE router, from where MPLS takes care of the further traffic flow.

IP Telephony Service: IP Telephony infrastructure has been established using the Data Network of GSI for voice communication within the organization.

Video-conferencing: Implementation of Video-conferencing facility includes installation of Main Control unit at various locations (DG, GSI's Office all Regions / Wings, Central Data Centre) have been completed and in few places like MOM, New Delhi, SRO, Liaison Office, New Delhi, GSITI, work is in progress.

Analytical Chemistry and the Chemical Laboratory Network

The GSI Chemical Laboratories with its large infrastructure constituting with 21 laboratories (CHQ, Regions : 6, Operations : 12 and erstwhile Wings: 2) located in almost all the states of the country is playing key supportive role for the successful completion of various time bound approved programmes / projects particularly the prestigious NGCM project, mineral exploration & prospecting, environmental studies, fundamental geoscientific studies etc.

Consequent upon the induction of NGCM programme to maintain the flow of output, all the laboratory facilities have been upgraded to a great extent by means of introducing various sophisticated state-of-the-art instruments like WDXRF, ICP-MS, DMA-80, GF-AAS, GC, HPLC, HG-AAS, TOC analyzer etc. for generating data bank from percentage level to below crustal abundance level.

The main thrust of the chemical laboratories is to analyse NGCM samples (mainly stream sediment and soil) for 68 elements determination at a very low level with high level of precision and accuracy. At present, based on the Laboratory equipment Standards available, analysis for 59 elements is being taken up.

Laboratory Network (Other than Chemical)

Research and developmental activities are carried out to supplement the work in the various field investigations and activity domains in the Geological Survey of India. Establishment of state-of- the-art instrumental facilities in the fields of Petrology, Geochronology and Isotope Geology, Palaeontology, Photogeology and Remote Sensing, Geophysics, Mineral Physics etc is in progress.

Drill Core Library

GSI has embarked upon preserving drill cores of selected drill holes of mineralized and stratigraphically important deposits for posterity with a view to create a National Drill Core Repository. Digital record of drill cores preserved would be maintained online through the Portal and a policy would be put in place which allows use of core samples by concession holders on appropriate terms and conditions.

Policy Support System

Planning, Programming and Monitoring

8.32 The Planning, Programming and Monitoring operation, with its different Monitoring Divisions, is

the nerve centre of CHQ as well as GSI and it acted in the domains of policy formulation, policy dissemination, linking-translating the decisions of different committees like CGPB Committee, advisory board of allied organisations and undertakings in the Annual Programme etc.

The Monitoring Divisions of the Operation monitored the items in various mineral commodities, mapping and specialized investigations of F.S. 2008-09. Norms and guidelines for field activities, e.g., Airborne Surveys, Engineering Geology, Landslide Hazard, Earthquake Geology, Marine Geology, Environmental Geology, Desert Geology, Geothermal, Glaciology, Medical Geology, Geophysical and Geochemical mapping etc. are set and periodic progress in specialised domains are monitored. Scrutiny of research projects emanating from various organizations under sponsorship of Department of Science and Technology was also undertaken. These divisions also participated in interactions with other agencies involved in earth science activities, like MECL, IBM, and DST etc. on various geoscientific matters. Planning Division looked after task force activity, budgetary managements of F.Y. 2008-09 and prepared budget estimates of F.Y. 2009-10 as well as the annual plan of GSI 2009-10, and modernization aspects while Parliament Cell provided information and supplementary details to MoM on Parliament questions.

GSI upgraded its existing 'Liaison office in Delhi' to 'DG's camp office in Delhi' and created the CGPB Secretariat, Science Policy & Coordination and Commercial Operation Divisions, as suggested by HPC.

Science Policy & Coordination

Science Policy & Coordination division will identify critical areas in field of geoscience in short, medium- and long-term periods, develop strategies, workout priorities for GSI over different timeframe, interact/ collaborate with other national and international organizations and suggest changes about infrastructural capabilities, skill mix and integrated approach to enable GSI to meet challenges.

CGPB Secretariat

CGPB Secretariat now operating from Delhi will help realizing the full potential of the CGPB mechanism with continuous interactions with the various stake holders of the geosciences sector.

Ms. Santa Sheela Nair, Secretary, Ministry of Mines addressing 46th Central Geological Programming Board Meeting held on 11-12 February, 2010

International Cooperation & Activities

8.33 Geological Survey of India (GSI) continued its international activities with various international governmental organisations/ scientific agencies through collaborative and bilateral exchange programmes in scientific projects, participation in international seminars, symposia, workshops, advanced foreign training programmes and in Indian Scientific Expedition to Antarctica and Arctic region.

International Geoscience Programme

International Geological Correlation Programme renamed as the International Geoscience Programme since 2004 with retention of its acronym IGCP and logo, was jointly established by UNESCO and IUGS in 1972. It contributes through coordinated interdisciplinary activities involving all branches of earth science to the prevention and solution of problems of the natural and social sciences with the objectives to serve the geoscientific needs of the society. India was one of the first few countries to support the IGCP since its launching. The activities of the IGCP projects in India are monitored by a duly constituted Indian National Committee (INC) for the IGCP, for which the GSI is the nodal agency and the Director General, GSI is the Ex-officio Chairman. At present there are fourteen INC members, from leading Indian scientific organisations/ institutes, which include AMD, NGRI, ONGC, INSA, WIHG and other distinguished universities. The INC identifies new projects from those already approved by

the IGCP Scientific Board, Paris, for Indian participation and reviews the progress of on-going projects as well as recommends new project proposals for future implementation. Eleven IGCP projects were in operation.

One hundred seventy two officers from GSI participated in 31 International / National training Programs, workshops, Fellowship/Scholarship programme and Seminar/ Symposia/Conventions.

GSI continued its interaction with other countries to explore possible bilateral cooperation and collaborative programmes. Details of MoUs and activities thereunder are given below:

Collaborating Country (and year of commencement)	Projects/Activities
Argentina 2009	• Exchange visits of scientists and specialists. • Exchange of scientific and technical information. • Joint research programme. • Collaboration on research of mutual interest. • Training of individual scientists through participation in collaborative projects. • Conducting joint symposia, conferences and seminars. • Other forms of cooperation as may be mutually agreed between the Parties.
Bhutan2007	Preparation of Detailed Project Report (DPR) for Punatsangchhu Hydroelectric Power Project – II
Canada 2003	• Arsenic toxicity in groundwater - Phase 2 • Scope for the utilization of state-of-the-art equipment for seismic micro-zonation • Long-term crustal deformation study and multi-hazards • Commercialisation of other scientific equipment • Landslide monitoring/ mitigation
Chile2009	Co-operation in the fields of Geology and Mineral Resources in geological mapping and mineral exploration in Chile and also can impart training to their geoscientists in several disciplines.
China 2005	• Technology transferring and training programme regarding modern geological mapping • Active fault mapping under seismic hazard assessment • Development of Geological database and Geographic Information System and their implementation in resources administration • Utility of low-grade deposits viz. nickel, gold, basemetal, cesium
Kazakhstan	• Mineral exploration in Kazakhstan through surface geological mapping (including geological, geochemical, geophysical mapping and aero-geophysical survey as necessary) with special emphasis on resources of copper, zinc and gold. • Off shore survey and exploration • Geo-environmental studies • Geology of water resources • Providing training facilities to the geoscientists of Kazakhstan at GSI Training Institute as per the need of the Kazakh side.
Namibia2009	The first meeting of the India – Namibia Joint Working Group on Geology and Mineral Resources was held at Namibia during last week of November 2009 which was led by Secretary (Mines).
Netherlands 2004	Collaboration in strengthening capabilities in the application of digital methods in geological, geophysical and geo-chemical mapping and geo-hazard assessment
Saudi Arabia2009	Training of scientific and technical personnel of Saudi Geological Survey (SGS) in GSI Training Institute
United States of America (Regents of the University of Colorado, Michigan University and California State University, Northridge, USA)2008	Rotation, Fragmentation and Flexure at the Northeast Corner of the Indian Plate

India-Africa Forum Summit

8.34 Two international courses on "Mineral Exploration and Remote sensing and Digital Image processing" for African Participants were conducted in October 2009 as per the decision taken in India-Africa Forum Summit. This is the first time that GSITI is conducting training for African Countries. There were in total thirteen participants from various countries e.g., Egypt, Botswana, Sudan, Senegal, Kenya and Zimbabwe. The objective of the training programs was to equip the earth scientists from African countries with latest techniques for exploration / exploitation of their countries' mineral resources.