

# Geological Survey of India (GSI)

Geological Survey of India (GSI) Established in 1851, started its voyage to investigate for and assess coal and other mineral resources of the country with regional level exploration. In the 160 years since its foundation, GSI has continued to grow and diversify into various geoscientific activities, and delivered impeccable contribution in the arena of geosciences. 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 and to meet the increasing demands of various stakeholders. Over the years, it has not only developed into a huge repository of precious geoscientific data applied in various developmental sectors in the country, but has also attained the status of a geo-scientific organisation of international repute. The principal function of GSI relate to creation and updation of national geoscientific data and mineral resource assessment, air-borne and marine surveys and conducting multifarious geo-technical, geo-environmental and natural hazards studies, glaciology, seismotectonics, etc. and to nurture studies on fundamental research. In all the developmental facets of the country including coal, steel, cement, metals/ minerals and power industries, GSI made neat contribution and remained relevant in the national context. Outcome of work of GSI has immense societal value as well as relevant to global perspective adopting state-of-the-art technologies and using methodologies, which are cutting-edge. Functioning and annual programmes of GSI assumes significance in the national perspective since it is directly related to delivering the public good. With its headquarters at Kolkata, GSI has six Regional offices at Lucknow, Jaipur, Nagpur, Hyderabad, Shillong and Kolkata and offices in almost all States of the country. The Geological Survey of India is an attached office to the Ministry of Mines. The Union Cabinet constituted a High Powered Committee (HPC) to thoroughly review the functioning of Geological Survey of India and assess its capacity to meet the emerging challenges taking into account the technological and manpower resources of the organization. The report of the Committee was submitted in March 2009 and approved by the Union Cabinet in October 2011. The revised organizational structure as proposed by HPC has largely been implemented.

## Activity Domain of GSI

The GSI is the prime provider of basic earth science data to the government, industry and the public, as well as responsive participant in international geoscientific fora. The vibrant steel, coal, metals, cement and power industries, which expanded phenomenally in the post-independence era, bear eloquent testimony to the GSI's relevance in the national context. Geoscientific work of GSI encompasses practically the entire gamut of earth sciences and thus great responsibilities are bestowed on the organisation. Earth science by its very nature is highly multidisciplinary and has immense societal values. With a view to remain relevant for the cause of the society, mankind, global perspective and its environment, GSI faced challenges of the time to reorient its organizational structure and strengthen its capacity building. In accordance with the HPC recommendations, GSI is executing its programmes through Mission-Region hybrid matrix mode with its five Mission offices and three Support Systems. Activities of GSI function around Five Missions / Seven Schemes and three Support Systems (Table: 8.1).

Table: 8.1

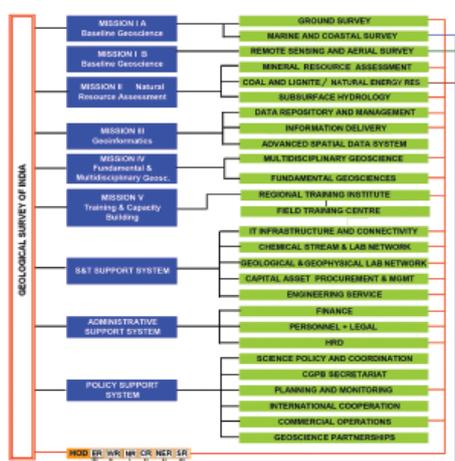
Mission/ Support System	Schemes	Components/Activities
Mission I - Baseline Geoscience Data generation	Survey & Mapping	Specialised Thematic Mapping, Geochemical Mapping, Geophysical Mapping, Systematic Geological Mapping, Airborne and Marine Surveys.

Mission II - Natural Resources Assessment	Mineral Exploration	Exploration for coal (including lignite), Ferrous, Non-Ferrous, Precious and Strategic and Industrial minerals.
Mission III - Geoinformatics	Information/ Dissemination	Map compilation and publication on various earth science subjects, Information Technology, GSI portal.
Mission IV - Fundamental & Multidisciplinary Geosciences and Special studies	Specialised Investigation	Geotechnical, environmental, landslide studies, earthquake geology and seismology, glacial, geothermal and desert geological studies.
	Research & Development	Research work on fundamental geoscience and Arctic and Antarctic studies.
Mission V - Training & Capacity building	Human Resource Development	Training
S & T Support System	Modernization	I.T. Infrastructure & Connectivity, Analytical Chemistry and the Chemical Laboratory Network, Capital Assets Procurement and Management, Drilling & Workshop, Transport, Survey
Administrative Support System		Finance, Personnel, Legal Cell, HRD Information and Publications, Libraries, Parks and Museums, Estates
Policy Support System		Science Policy & Coordination, Planning & Monitoring, CGPB Secretariat, International cooperation, Commercial Operations, Geoscience partnerships

The “Missions” recommended by the HPC are operational and activities and budget of GSI are following the “Mission” concept. GSI’s Field Season programmes of 2009-2010 and 2010-2012 have been executed on Mission-Region Hybrid matrix Figure: 8.1.

The Financial Performance of GSI against the approved plan outlay during 2007-08, 2008-09, 2009-10, 2010-11 & 2011-12 (till Dec’11) i.e during XI Plan is summarized in Annexure 8.1.

Figure: 8.1  
GSI–Mission Region Matrix.



## Restructuring of GSI

The Expenditure Reforms Commission (ERC) 2001 had in its report recommended rightsizing the staff strength of GSI from the strength of 16,302 to 9,000. The ERC had also recommended setting up an Expert Committee to suggest a revised charter of functions for GSI, and identify the disciplines/groups where reduction of personnel could be effected. The Expert Committee headed by Shri Arvind Varma, Former Secretary to the Government of

India in 2002, recommended a revised charter of functions for GSI, which was adopted by the Government.

The High Powered Committee Report in 2009 has given a new Charter for GSI and has accordingly recommended a substantial increase in the scientific personnel strength of GSI and Union Cabinet has approved the net increase of 713 Group-A posts; 451 Group-B posts and 189 Group-C posts of S&T streams.

The total strength of Scientific and non scientific personnel is projected to rise from 11420 to 12369 over a period of ten years i.e. actually 8.3% increase.

Like Geology stream the other streams Geophysics, Chemistry and Engineering have become 'organized service' with the approval of the Cabinet note by the Union Cabinet on 25<sup>th</sup> October 2011.

As per the recommendation of HPC, and approval of Union Cabinet on 25th October 2011 the revised strength of different S&T cadres in GSI are given at Table 8.2.

Table 8.2

Streams	Sanctioned posts before HPC				Increased strength with Cabinet approval			
	Gr.A	Gr.B	Gr.C	Total	Gr.A	Gr.B	Gr.C	Total
Geology	2428	272	150	2850*	2786	660	150	3596*
Geophysics	410	170	70	650**	555	220	70	845**
Chemistry	328	262	110	700	509	315	150	974
Engineering	90	330	530	950	90	416	744	1250
Survey	2	201	65	268	31	319	-	350
Drawing	-	362	50	412	-	118	50	168
Total	3258	1597	975	5830	3971	2048	1164	7183

(\* : Includes Director General Post)

(\*\* : Includes mineral physics and instrumentation)

## 8.4 Implementation of recommendations of High Powered Committee (HPC), after the approval of "Restructuring of GSI" by Govt. of India:

Background: The Union Cabinet in its meeting on 1<sup>st</sup> October, 2007 decided to set up a High Powered Committee (HPC) to thoroughly review the functioning of the GSI and assess its capacity to meet the emerging challenges taking into account the organization's technological and manpower resources. The Committee submitted its "Report on the Functioning of the Geological Survey of India" to the

Government on 31<sup>st</sup> March, 2009. The then Hon'ble Minister of Mines accorded in-principle approval for implementation of the recommendation of HPC on 1<sup>st</sup> May, 2009.

The process to implement HPC recommendation was started in the Ministry in the end of year 2009 and in that direction the first draft note on restructuring of Geological of India was circulated for seeking comments of other ministries/department on 10<sup>th</sup> December, 2009 and after long Inter Ministerial consultation, the Union Cabinet in its meeting dated 25<sup>th</sup> October, 2011 approved the "Restructuring of

#### Status of implementation in respect of establishment matters as on 30<sup>th</sup> December, 2011:

- The Union Cabinet has approved "Restructuring of GSI" on 25<sup>th</sup> October, 2011 and following is approved Govt. of India:-
  - (a) The total GSI strength was 'right sized' with total strength of 12369.
  - (b) The post created by Cabinet approval will be filled up over a 10-year period to achieve full strength.
  - (c) The Govt. has approved constitution of Group 'A' posts of Geophysics, Chemistry and Engineering of (S&T Streams) GSI into Organized Services.
  - (d) Exemption for a period of three years of all Science & Technical posts from the purview of Department of Expenditure instructions on posts that remain unfilled for more than one year.
- Finance cells created in each Region with Director Level Officer as In-charge.
- Policy, dated 22<sup>nd</sup> August, .2011 on "Foreign Deputation by GSI officers" issued.
- Cadre Review of Group 'A' Geology, Geophysics, Chemistry and Engineering streams approved by the Cadre Review Committee of the Government of India on 4<sup>th</sup> March, 2011.
- Recruitment Rules of Group 'B' {Gazetted & Non-Gazetted} and Group 'C' for Geology, Geophysics, Chemistry, Survey and Drawing Streams sent to DoPT on 5<sup>th</sup> December, 2011 for concurrence and approval. As regards Engineering Stream it was sent to DoPT on 22<sup>nd</sup> December, 2011.
- Recruitment Rules of Group 'A' 'B' Group 'C' for non-S&T and other miscellaneous streams after Cabinet approval is under process and will be sent to DoPT for concurrence after approval.
- GSI training Institute to commence Post PG Diploma Certificate course in Geoinformatics. First course to commence in third week of 21<sup>st</sup> September, 2011.
- Prospective plan for outsourcing of vehicle for field and operational unit for next five years is under finalization.
- Circulars regarding Purchase Advisory Committee (PAC) & Technical Advisor Committee (TAC) has been issued by Asset Management & Procurement Division of GSI on 26<sup>th</sup> August, 2011.
- Notification issued by GSI on 29<sup>th</sup> December, 2011 to give effect Govt. of India approved discipline wise new sanctioned strength of GSI.

Union Cabinet has approved restructuring of GSI as per HPC recommendation on 25<sup>th</sup> October, 2011.

GSI issued notification No. 8360A/HPC/GSI/2011 dated 29<sup>th</sup> December, 2011 on 'Manpower strength as approved on 'Restructuring of GSI, 2011' and Operation Mechanism in respect of different disciplines':-

- (a) Vision & Charter - Gazette notification issued on 25<sup>th</sup> May, 2009 and put up on website of Ministry of Mines & Portal of GSI. Wide publicity has been given within and outside GSI.
- (b) GSI has been declared as an 'Attached Office' on 7<sup>th</sup> July, 2009 in the Ministry of Mines, upgrading it from 'Subordinate Office'
- (c) GSI has switched over to the Mission-Region mode and the Field Season 2009-2010 and 2010-2012 has been conducted in Mission-Region matrix Mode.
- (d) 'Mission Offices' have started functioning. Three Support Systems are created.
- Orders for Mission-I, II, III, IV, V and PSS circulated.
  - Orders for Restructuring of Coal Wing issued on 5<sup>th</sup> April, 2010.
  - Orders for Restructuring of Marine Wing issued on 13<sup>th</sup> April, 2010.
  - Orders for Restructuring of AMSE issued on 13<sup>th</sup> April, 2010.
  - Order on Placement Collegiums was issued on 6<sup>th</sup> April, 2010.
  - Officials of various levels undergone / undergoing training in finance and administration by outside reputed Institutions.
  - Framing of transfer policy as per guidelines given by HPC has been done and being implemented.
  - Fund allotment on Mission Mode implemented from 1<sup>st</sup> April, 2010
- (e) Resolutions Orders for Mission-I, II, III, IV, V and Policy Support System circulated. Regarding S&T Support System [STSS] and Administrative Support System [ASS] draft resolutions ready and are under scrutiny.
- (f) The following Collegiums, to manage HRD related issues have been established:
- Collegium for Deployment and redeployment and new postings of officers.
  - Collegium for faculty selection in GSITI.
  - Collegium for Concept paper on Shipping, Security of GSI Buildings.
- In addition the following Collegiums have been established for non-HRD issues:
- Collegium for approving prioritised SOPs.
  - Collegium for variance analysis of NGGM samples
  - Collegium for reviewing the peer reviewed reports.
- The Collegiums were also established for the following issues:
- Collegium for changes in the scheme of Geologists Exam. 2011.
  - Collegium for review of Modernisation Report of GSI.
  - Collegium for review of DPR submitted by NISG i.r.o. OCBIS
  - Collegium for posting in Dir(T)
- (g) Meeting to discuss issues regarding change in scheme of Geologists Examination in UPSC with AS(E) on 15<sup>th</sup> June, 2011.
- (h) Finance cells created in each Region with Director Level Officer as In-charge.
- (i) Modernization Committee Report has been finalized and approved in 49<sup>th</sup> CGPB.
- (j) Policy, dated 4<sup>th</sup> August, 2010 on change in Field Season Program period, making it in sync with financial year, issued.

- (k) Policy, dated 23<sup>rd</sup> September, 2010 on Field duration, for different geoscience domains issued and implemented.
- (l) Policy, dated 3<sup>rd</sup> September, 2010 on grant and regulation of Rolling Contingent Advances/Non-Rolling Contingent Advances to field operations issued and implemented.
- (m) Policy, dated 22<sup>nd</sup> August, 2011 on “Foreign Deputation by GSI officers” issued.
- (n) Central Geological Programming Board (CGPB) has been revamped and 12 Committees constituted on 12<sup>th</sup> March 2009. These Committees are fully functional.
- (o) Order for establishing Science Policy Coordination, CGPB Secretariat, Commercial Operation (all new) and additional office of DDG (P) at Delhi has been issued by GSI on 29<sup>th</sup> June, 2009. Quality Management cell has been notified to be located at Delhi.. A road map on the functioning of different divisions of DGCO formulated.
- (p) GSI has finalized plan to establish a National Drill Core Library at Hyderabad.
- (q) Order for dissemination of Geoscientific information gathered by GSI for use by public at large made free of cost and related orders issued on 5<sup>th</sup> June, 2009. GSI has drawn an action plan for digitizing and uploading the information.
- (r) GSI is to develop a special group of Geoinformatic personnel drawn from all the major streams i.e. Geology, Geophysics and Chemistry so that over time GSI has a unique national human resource - order issued vide Letter No. /D-19015/07/IT/OCBIS Director[Technical] 26<sup>th</sup> April 2011
- (s) GSI to invest in cyber-infrastructure, Develop geoscientific data standards and management policies etc- order issued vide letter no. 648/19015/07/IT/2011 dated 25<sup>th</sup> November, 2011.
- (t) Recruitment Rule (RR) of Geology stream as ‘Organized Service’ has been notified as Gazette Notification on 29<sup>th</sup> September, 2010.
- (u) Training System in GSI has been revamped. Special Mission for training has been constituted. Partnership with other training institutes in geoscience sector is envisaged. GSI has started imparting training to the officials of the State Governments in GSI’s Training Institute free of charge. A post of Training Manager to oversee the functioning of GSITI has been created.
- (v) Six Regional Training Institutes (RTI) have been operationalised at the six Regional Headquarters under GSITI. The Field Training Centres of GSITI located in different parts of the country (FTCs) shall be conducting field-based courses on different themes of earth sciences.
- (w) GSI training Institute commenced Post PG Diploma Certificate course in Geoinformatics.
- (x) Report on training needs assessments is expected to be submitted by February 2012.
- (y) Vehicle repair workshops have been closed since 31<sup>st</sup> July, 2009 and job work has been given on outsourced basis.
- (z) The peer-reviewed Standard Operating Procedures, for functional domains has been finalized and uploaded. Hard copy of operating procedures pertaining to Mission 1A also released.
- (aa) Proposal to setup ‘Geoscience Advisory Council’ has been approved by the Hon’ble Prime Minister’s Office. First meeting was held in September 2011.
- (ab) For setting up ‘Indian Geosciences Congress’ as a registered Society, laws and byelaws governing such society drafted, papers sent to Planning Commission for ‘in principle’ approval before obtaining cabinet approval.

(ac) Geophysics, Chemistry and Engineering, Group 'A' in GSI to be accorded 'Organised Service' status as approved by the Cabinet on 25<sup>th</sup> October, 2011. Draft Recruitment Rules on 'organised service' pattern for the above mentioned streams have been submitted to DoPT for approval on 6<sup>th</sup> January, 2012.

(ad) **Quality Management Cell of GSI**

**Peer Review of GSI Field Reports**

The peer review of reports has been introduced in GSI at the instance of MoM to improve the overall quality of GSI reports.

FS: 2007-08 (10% reports)

Total reports generated: 230 reports

No. of Reports randomly picked up for peer review (10%): 33 reports

No. of peer reviewers: 11

**Status: Peer Review completed**

Action taken: The peer reviewed reports were analysed by the QM Cell and by a collegium constituted by the DG, GSI, and after approval by the DG, GSI, the recommendations of the collegium regarding modification and resubmission of the 6 reports have been sent to the respective Regions for immediate compliance. The other reports also have been sent back to the respective Regions for circulation among field and supervisory officers for educative purpose and for improving the Quality of reports in the future.



Secretary (Mines) Shri Vishwapati Trivedi at Stona 2012 Exhibition

### Field Season (FS): 2008-09 (20% reports)

Total reports generated: 202 reports

No. of Reports randomly picked up for peer review (20%): 62 reports

No. of peer reviewers: 20

### Status: Peer Review completed

Action taken: The peer reviewed reports were analysed by the QM Cell and a collegium constituted by the DG, GSI, and after approval by the DG, GSI, the recommendations of the collegium regarding modification and resubmission of the 9 reports have been sent to the respective Regions for immediate compliance. The other reports also have been sent back to the respective Regions for circulation among field and supervisory officers for educative purpose and for improving the Quality of reports in the future.

### FS: 2007-08 (additional 10% reports)

Total reports generated: 230 reports

No. of Reports randomly picked up for additional peer review (10%): 19 reports

No. of peer reviewers: 7

### Status: The Peer Reviewed reports are being received back (15 reports received) after review.

Action taken: The peer reviewed reports will be analysed by the QM Cell and collegium constituted by the DG, GSI, for further necessary action.

### FS: 2009-10 (10% reports)

Total reports generated: 282 reports No. of Reports randomly picked up for additional peer review (10%): 30 reports

No. of peer reviewers: 17

### Status: The Peer Reviewed reports are being received back (2 reports received).

Action taken: The peer reviewed reports will be analysed by the QM Cell and the collegium constituted by the DG, GSI, for further necessary action.

### Preparation of Modus operandi for fieldwork and report scrutiny

The QM Cell has prepared detailed 'modus operandi' and 'flow charts' for

1. Quality Management at SHQ and RHQ levels and reporting system at various levels.
2. Report scrutiny at various levels and uploaded the same in GSI portal for comments/review. These have been reviewed by a collegium and after approval by the DG, GSI will soon be implemented in GSI.

### ISO Certification of GSI (Regional) Chemical Labs

Seven coordinators were selected from the Regional chemical Labs and the Central Gem Testing lab and trained at IIQM, Jaipur on "Laboratory Quality Management System and Internal Audit as per ISO 170025:200)" from 10-13 May 2011.

The QM Cell has arranged a study visit for the 14 officers from the selected labs to the ISO Certified ONGC Labs at Dehradun on 17<sup>th</sup> October, 2011

The proposal for engaging a consultant for ISO Certification of Labs is under consideration.

### Rechecking of 5% NGCM samples analysed during FS: 2008-09

The QM Cell received 345 duplicate NGCM samples for reanalysis from the six Regions, along with the original analytical results. Thereafter, the QM Cell selected 292 samples for rechecking and after false numbering them, were sent to different Regional Chemical Labs for reanalysis, under various NGCM packages. The QM Cell has subsequently received a majority of the results of reanalysis of the samples. The QM Cell is now analysing the results for variance.

### Modernisation drive in GSI

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:

- (i) Procurement of a new ocean going research vessel in replacement of GSI's existing Research Vessel Samudra Manthan: underway [GSI has signed contract agreement for the construction of a ship as a research vessel with M/s Wartsila Ship Design, Norway AS on 28<sup>th</sup> November, 2009. The Ship Acquisition Cell (SAC) of M&CSD is monitoring the progress on a day to day basis and Task Force reviews the progress at regular intervals and providing direction to the SAC. Review meetings with the consultants appointed for the project (M/s Shipping Corporation of India and M/s Wartsila Ship Design, Norway) are being organized regularly. A team of MoM and GSI had visited Ulsan, S. Korea (between 7<sup>th</sup> June, 2011 to 11<sup>th</sup> June, 2011) for a kick-off meeting with M/s HHI for discussing various issues related to project management, progress and finance requirements, status of POS etc. Representatives of the consultants also participated in the meeting. Two batches of GSI Scientists (10 officers each) went for foreign training on Multichannel Seismic Systems and Gravity-Multibeam at Lamont Doherty Earth Observatory (LDEO) Palisades, New York, USA. One batch returned on 17<sup>th</sup> October, 2011 after completion of training in Gravity and Multibeam at the Institute. The trainings are being organised by M/s Wartsila Ship Design, Norway (consultants) as part of fulfilment of terms of agreement in connection with acquisition of Ocean Going Research Vessel. M/s Hyundai Heavy Industries (M/s HHI), Korea, the shipyard where the new vessel is under construction submits monthly progress report which is scrutinized by the consultants and GSI. The second installment has been paid on 29<sup>th</sup> September, 2011 to M/s HHI. M/s HHI assured that the third milestone (steel cutting) will be achieved by 12<sup>th</sup> March 2012 and the third instalment will be paid after that in the month of March, 2012. Revised Proposal for allotment of required fund for the payment of the third instalment of ` 86.87 at ` 49.34 per dollar (24<sup>th</sup> November, 2011) equivalent to USD 17,605,500 had been raised in the Second Supplementary Demand and the fund has been allotted to GSI].
- (ii) Procurement of a Heliborne Geophysical Survey System for GSI at a cost of ` 52.00 crore: almost complete [DGCA has issued permission to HAL for handing the CAMO and CAME operations of Dhruv Helicopter during installation and integration of geophysical sensors. The integration of sensors with the Helicopter by M/s Hindusthan Aeronautics Limited (HAL), Bangalore is under progress. HAL, as per new schedule, will hand over the helicopter after all certifications etc. by end of February 2012. The training of pilot is the responsibility of the O&M agency, which is going to take charge of the Helicopter once the HAL hands it over.
- (iii) Acquisition of a new Geotechnical Vessel with shallow drilling capacity for GSI at a revised cost of ` 70.20 crore: Proposal finalized. The final copies of Request For Proposal (R.F.P.) for Selection of Shipyard for Acquisition of Geotechnical Vessel with Shallow Water Drilling

Facility for Geological Survey of India (Marine and Coastal Studies Division) have been sent to the eighteen short listed shipyards on 19<sup>th</sup> / 20<sup>th</sup> October, 2011 by speed post. The pre-bid meeting has been organized on 22<sup>nd</sup> and 23<sup>rd</sup> November, 2011. All the clarifications sought by the shipyards have been answered and corresponding amendments are being compiled for onward transmission to all short listed shipyards. The estimated cost of the vessel is ` 70.2 crore including consultancy charges as approved by the Departmental EFC subject to the outcome of the tendering process.

- (iv) Laboratory and IT equipment: In addition, as a part of modernization drive GSI has been purchasing laboratory and field equipments besides the Ocean going vessel, Helicopter etc. and the detailed list of Items along with the expenditure towards such purchase is tabulated in Table: 8.2.

### Free Data Policy

Documents (both text and graphic) generated and circulated by GSI are basically of two types: (a) printed and published 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 Government on 5<sup>th</sup> June, 2009 and free data policy is presented at Annexure - 8.3.

Since initiation 34,858 metadata of unpublished reports have already been uploaded to GSI Portal till December 2011 along with the uploading of 9231 unpublished reports and during the FY 2011-2012, 353 reports have been circulated till December 2011.

### Performance of GSI During 2011-2012

Summarised performance of GSI with physical target and achievement for last three financial years (2009-10, 2010-11, 2011-12, up to December 2011) of XI Plan Five Year Plan (2007-2012) is presented at Annexure 8.2.

## MISSION-I: BASELINE GEOSCIENCE DATA GENERATION

### Systematic Geological Mapping

Systematic Geological Mapping on 1:50,000 scale, the fundamental geological mapping programme, has been carried out by GSI for past few decades and has catered most basic geologic data to the National Geoscientific knowledge base. Out of the 3.146 million sq. km mappable area, 3.094 million sq. km have so far been covered by systematic mapping, bringing the total coverage to 98.36%. Systematic Geological Mapping of an area of about 620 sq km in parts of Zunheboto, Mon, Kiphire, Tuensang and Phek districts in Nagaland and Dibrugarh, Kamrup and Goalpara districts of Assam has been completed in the Financial Year 2011-12 upto December 2011.

### Specialised Thematic Mapping (STM)

GSI 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. During the FY 2011-12 (up to December 2011) an area of 6326 sq km has been covered by specialised thematic mapping. While a total area of 36,498 sq km has been completed during the XI Plan period upto December 2011, and 14,416 sq km has been covered in the current FS 2010-12 (till December 2011).

## Geophysical mapping

Systematic ground gravity - magnetic surveys under the Geophysical Mapping (GPM) programme was 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. During the FY 2011-12 (up to December 2011), an area of 13,268 sq km has been covered under GPM programme. During field season 2010-2012, a total of 22,930.5 sq km area has been covered and during the XI Plan period upto December 2011 an area of 96,201.5 sq.km. has been covered.

## Geochemical mapping

National Geochemical Mapping (NGCM) Programme in India was initiated by GSI in 2001-02 with 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 a consistent set of methods. These data will comprise a complete, national-scale geochemical coverage of the Indian land area and will enable preparation 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. A NGCM database is being created centrally with the intention of producing maps depicting geochemical anomalies requiring detailed investigation for various purposes including mineral investigation. During the FY 2011-12 (up to December 2011), an area of 27,198 sq km has been covered systematically under the National Geochemical Mapping Programme. During field season 2010-2012, a total of 43,976.6 sq km area has been covered and during the XI Plan period upto December 2011 an area of 1,20,886.6 sq.km. has been covered.

## Remote Sensing and Airborne Survey

- (i) Airborne Geophysical Surveys are being carried out by the Twin Otter Airborne Survey System (TOASS) with Magnetic and Gamma Ray Spectrometric sensors acquired by GSI in 1986. Since then (up to F.S. 2009-2010) a total of 4,90,923 line km over an area of 2,91,976 sq.km. was covered by deploying multi sensor systems. A total of 14,761 lkm. (36,902 sq.km.) was flown over parts of West coast from Hosadurga to Vengurla, over parts of Karnataka and Maharashtra. The flight (TOASS) was operative till April, 2010 and since then due to the break down of the Navigational System PNAV-2100, no airborne survey could be conducted and the repairing process has been initiated. The equipments for repairs/ replacement of TOASS were received from Canada and were tested and integrated by the engineers of PicoEnvirotec, Canada. The equipments were taken to the airport of "Taneja Aerospace and Aviation limited"(TAAL) for installation in the Twin-Otter aircraft, which has been completed. The TOASS system was repaired and tested. The test flights were conducted after integration and checked for the data quality and found satisfactory.
- (ii) As part of the modernization programme, GSI has 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. The first Heliborne survey is planned over a test area, which has been flown earlier over known mineralization for testing the response of different sensors after their installation is over.



Airborne Survey

- (iii) A proposal for National Geomorphological and Lineament Mapping on 1:50,000 scale was approved with GSI and ISRO as nodal agencies for quality and execution. As per the project proposal the entire work is to be carried out through outsourcing and 32 partner institutes under the control of National Remote Sensing Center (NRSC) as working centers were selected. The geo-referenced LISS - III data along with manual and NRCGeom software developed by them handed over in February 2010 to different partner institutes. The Standard Operating Procedure (SOP) document for External Quality Check (EQC) was finalised by GSI and NRSC. PGRS Divisions of GSI were entrusted with the responsibility of external quality checking (EQC) and project execution. The work is in progress and 732 nos. of EQC completed by the end of December 2011.
- (iv) Development of Hyperspectral sensor for mineral mapping is being stressed upon as it is very effective and sophisticated tool for identifying mineral deposits. For this, building up

of spectral library of minerals and rocks in Indian context is a prerequisite. During FS 2010-12, Hyper spectral remote sensing studies continued under 4 programmes: Sargipalli shear zone, Sundargarh District, Orissa; Kharkari River - Rajdah Sector of Singhbhum shear zone, Singhbhum District, Jharkhand; Precambrian terrain of Eastern and Northern Gujarat; Sakoli mineralized belt, Bhandara district, Maharashtra.

### Marine and Coastal Surveys

1. Geological Survey of India has completed seabed mapping of 1,29,200 sq km out of 1,50,000 sq km in 5 km x 2 km grid within TW and 18,49,178 sq km out of 18,64,900 sq km in the EEZ (beyond Territorial Waters) on reconnaissance scale of 40 km x 20 km grid. The total EEZ coverage including TW is 19,78,378 sq km out of a total EEZ area of 20,14,900 sq km upto December 2011.



Offshore Exploration

2. During FS 2010-12 (up to December 2011), 7175 lkm of bathymetry, 6895 lkm of magnetic survey and 73,803 sq km multibeam swath bathymetry has been completed by the cruises of RV Samudra Manthan. In addition, systematic coverage within Territorial Water for 1580 sq km has been covered by RV Samudra Kaustubh and RV Samudra Shaudhikama along with coverage of 3785 lkm bathymetry, 1993 lkm of shallow seismic, 2185 l km magnetic and 286 sq km multibeam bathymetry.
3. Marine geoscientific programmes during FS 2010-12 (Upto December 2011) comprised the following:
  - (A) Eight cruises were mounted onboard RV Samudra Manthan within EEZ covering-
    - Multibeam Bathymetric Survey to the East of Nicobar Islands between West Andaman Fault and Sewell Rise was taken up from 10th November to 2nd December 2010 (SM-214)
    - Study of sea bed morphology and magnetic anomaly pattern across the arc-trench gap of Great Nicobar Island was taken up from 6th December to 29th December, 2010 (SM-215)
    - Studies on geomorphological configuration of Barren Island along with acquaintance of multibeam ecosounder was taken up from 2<sup>nd</sup> January to 8th January 2011(SM-215A)
    - Systematic magnetic survey in Bay of Bengal over 850 E Ridge and Multibeam Bathymetric Survey of the three submarine valleys off Pondicherry was taken up from 20th January to 13th February 2011 (SM-216).
    - Search for possible occurrence of phosphatic sediments off Ratnagiri, Maharashtra was taken up from 17<sup>th</sup> February to 13<sup>th</sup> March 2011(SM-217)
    - Multibeam Bathymetric Survey of the continental slope off Gopalpur - Kalingapatnam - Pudimadaka, Orissa (Andhra Pradesh coast) was taken up from 10<sup>th</sup> April to 4<sup>th</sup> May 2011(SM-218)
    - Study of the sea bed morphology and magnetic anomaly pattern across the arc-trench gap off Great Nicobar Island was taken up from 22<sup>nd</sup> October, 2011 to 8<sup>th</sup> November, 2011(SM-219)

- Multibeam Bathymetric Survey to the East of Nicobar Islands on the seawall Rise was taken up from 14<sup>th</sup> November, 2011(SM-221)
  - Multibeam bathymetric survey to the east of Nicobar Islands on the Seawall Rise was taken up from 12<sup>th</sup> November, 2011 to 6<sup>th</sup> December, 2011(SM-221).
  - Monitoring of changes of Curie Isotherm around Barren Island and Multibeam bathymetric survey around the Barren Island was taken up from 12<sup>th</sup> December, 2011(SM-220).
- (B) Eight cruises were mounted onboard RV Samudra Kaustubh within Territorial Water (TW) of the East Coast of India covering:-
- Placer Mineral resource evaluation in the territorial waters off Bhimunipatnam, Andhra Pradesh was taken up between 27<sup>th</sup> October 2010 to 20<sup>th</sup> November, 2010 (ST-216)
  - Placer mineral resource evaluation in the territorial waters off Palur - Malud, Orissa was taken up from 22<sup>nd</sup> November 2010 to 16<sup>th</sup> December 2010 (ST-210)
  - Geotechnical appraisal off Harichandi - Puri, Orissa was taken up in the period between 20<sup>th</sup> December, 2010 to 4<sup>th</sup> January 2011(ST-211)
  - Parametric surveys between Gopalpur and Dhamara areas of Orissa coast was taken up from 7<sup>th</sup> January to 13<sup>th</sup> January 2011(ST-212)
  - Parametric Survey within Territorial waters off Porto Novo and north of Pondicherry, Tamilnadu was taken up from 25<sup>th</sup> January to 18<sup>th</sup> February 2011(ST-213)
  - Mapping of seabed within Territorial Waters north-east of Point Calimere, Tamilnadu was taken up from 22<sup>nd</sup> February to 18<sup>th</sup> March 2011(ST-214)
  - Parametric (Magnetic, Seismic & Bathymetric) surveys between Bhimunipatnam to Kalingapatnam off north Andhra Pradesh coast was taken up from 28<sup>th</sup> March to 19<sup>th</sup> April 2011(ST-215)
  - Placer Mineral resource evaluation in the territorial waters Bhimunipatnam, Andhra Pradesh was taken up from 9<sup>th</sup> November, 2011 to 28<sup>th</sup> November, 2011(ST-216)
  - Study of the seabed morphology in the outer continental shelf off Chhatarpur, Orissa was taken up from 5<sup>th</sup> December, 2011 to 28<sup>th</sup> December, 2011 (ST-217)
- (C) Six cruises were mounted onboard RV Samudra Shaudhikama within TW of the West Coast of India covering-
- Mapping of the seabed off Okha, Gujarat Coast was taken up between 03<sup>rd</sup> November and 22<sup>nd</sup> November 2010 (SD-230)
  - Swath bathymetric survey of part of Gulf of Cambay off Valsad, Gujarat was undertaken from 1<sup>st</sup> December to 26<sup>th</sup> December, 2010 (SD-231)
  - Parametric (Seismic and magnetic) survey in the shelf area off Vzhinjim-Kanyakumari, Kerala & Tamilnadu coast was taken up from 30<sup>th</sup> December 2010 to 23<sup>rd</sup> January 2011(SD-232)
  - Evaluation of relict sand body off Shertallai, Kerala was taken up from 27<sup>th</sup> January to 20<sup>th</sup> February 2011(SD-233)
  - Geotechnical appraisal off Kulai, Karnataka was taken up from 24<sup>th</sup> February to 20<sup>th</sup> March, 2011 and again from 28<sup>th</sup> March to 2<sup>nd</sup> April, 2011 (SD-234)
  - Parametric (magnetic) survey within Territorial waters of Gulf of Mannar was taken up from 12<sup>th</sup> April to 4<sup>th</sup> May, 2011(SD-235)
  - Mapping of the seabed off Okha, Gujrat was taken up from 3<sup>rd</sup> December, 2011(SD-236)

(D) Other Programmes during FS 2010- 12 included:

- Study of seabed sediments from around West Andaman Fault and Central Andaman trough to delineate zones of hydrothermal activity. (Item:065)
- Test diameter mean test size variation of *Orbulina universa* d'Orbigny during last Glacial-Interglacial transition - study from a Central Bay of Bengal deep sea core. (Item 066)
- Geological appraisal of Azhikkal Port, Kannur, Kerala (Item 063).
- Preliminary Geological studies at Ponnani Harbour, Kerala (Item 061)

## MISSION- II: NATURAL RESOURCE ASSESSMENT

### Mineral Resource Assessment

The New Mineral Policy (2008) envisages the Geological Survey of India to perform the tasks of regional survey and exploration for minerals and the private sector to be the main source of investment in reconnaissance and exploration. The government agencies will expend public funds primarily in areas where private sector investment will not be forthcoming. The exploration activities of GSI have been prioritized keeping in view the thrust accorded by the Government of India, the directives given by the Planning Commission, the recommendations of CGPB and SGPBs and the requests received from State Governments.

GSI's work under mineral exploration programme is mainly confined within the limits of 'reconnaissance' [4] and 'prospecting'[3] though in some cases it also encompasses 'general exploration' [2] [United Nation Framework Classification (UNFC): G- axis]. Thus the resource estimates by GSI comes under the category of '334' [reconnaissance mineral resource]; '333' [inferred mineral resource] and '332' [indicated mineral resource] under the UNFC. GSI has been tasked to revisit its exploration reports from the FS 1998-99 to 2008-09 to make it UNFC compliant and all the exploration reports pertaining to the period (666 nos) are presently UNFC compliant. Mineral commodity-wise exploration block database is also being prepared, which is in consonance with GSI's 'geoinformatics' programme initiated during the year 2000. A renewed thrust will be given to this programme to prepare a 'mineral inventory' during the XII<sup>th</sup> Plan. GSI has also been identified as the nodal agency for archiving of the RP reports and dissemination of the RP report data after the lock-in period of two years.

The significant highlights of mineral investigations during the Field Season 2010-12 are as follows:

### Gold

- Gold ore resource has been estimated for Ajjanahalli Block C, Tumkur district, Karnataka, where Prospecting stage (G-3) exploration was completed during F.S. 2009-10. An inferred resource (333) of 0.9946 million tonnes with average grade of 2.17 g/t at 1 g/t cut off was estimated. In Ajjanahalli East block (B-block-south of A-Block), Chitradurga district, which was explored during F.S. 2006-08, an indicated resource (332) of 0.36 million tonnes of gold ore with 1.35 g/t Au at 0.5 g/t cut off and alternatively, 0.12 million tonnes with 2.71 g/t at 1.0 g/t cut off has been estimated.
- Investigations for gold are being carried out in the states of Jharkhand, Bihar, Karnataka, Andhra Pradesh, Rajasthan, Uttarakhand and Chhattisgarh.
- Gold exploration was carried out in Proterozoic rocks of Sonapahari area, Sonbhadra district, U.P. which involved both the surface trenching and sub-surface drilling to prove lateral as well as depth continuity of the zones in order to evaluate the mineralisation potentiality.

- The trenches excavated along various drill holes and the intervening areas indicated low Au values with only limited zones of + 1 g/t Au. Such zones include 1.61 g/t /1m; 1.12g/t Au/1.00m; 1.25 g/t Au/1.00m; 5.25g/t Au/1.40m and 1.5 g/t Au /1.50m
- The analytical results nineteen test drill holes indicate lean Au value generally ranging from 0.1 -0.4 g/t Au except for 4.30 g/t Au/0.77 m and 1.14 g/t Au/1.30 m respectively indicating a zone of + 1.00g/t Au over more than 170 m.
- Tentative ore grade and reserve estimation this ore body in block H has indicated 52806.25 tonnes of ore of 3.03 g/t Au of average grade of probable and possible categories.
- The exploration carried out down to shallow depth of 50 m confirms gold mineralisation of lean value and continuation of zones up to 100m depth.

### Molybdenum

- In Vellampatti area, Dharmapuri district, Tamil Nadu, which was explored during F.S. 2009-10, an inferred resource (333) of 2.74 million tonnes of molybdenum ore with an average grade of 0.102% Mo has been estimated.

### Platinoid Group of Elements (PGE)

- In Hanumalapura Block-A, Davanagere district, which was explored during F.S. 2005-08, a Reconnaissance resource (334) of 0.84 million tonnes of PGE ore with 0.50 to 2.93 g/t Pt+Pd has been estimated.
- PGE investigations are being carried out in the states of Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh, Kerala, Orissa and Manipur.



Mineral Resources

### Basemetal

- In Bishkhan Khari block, Betul district, Madhya Pradesh, which was explored during F.S. 2006-09, an indicated resource (332) of 1.91 million tonnes of zinc ore with 1.14% Zn has been estimated.
- In Jangaldehri block, Chindwara district, Madhya Pradesh, which was explored during F.S. 2008-09, an indicated resource (332) of 0.98 million tonnes of Zn ore with 1.10% Zn has been estimated.
- Investigations for basemetals are being continued in the states of Rajasthan, Maharashtra, Jammu & Kashmir, Haryana, Sikkim, Gujarat, Himachal Pradesh and Meghalaya.

- A new find of copper mineralisation in Khera Block, Mundiawas-Khera area, Alwar district, Rajasthan. Khera block is located nearly 5 km SSW of Thanaghazi, district Alwar, Rajasthan in part of toposheet no. 54 A/ 7.

On the surface, three zones of mineralization (MZ-I, MZ-II and MZ-III) manifested by malachite stain, presence of old workings and occasionally fresh sulphides in the form of bornite, chalcopyrite and pyrite are delineated during the current field season.

The first borehole KBH-1 intersected a 107.60 m thick mineralised zone (60.70m to 168.30 m along the borehole) with 0.29% Cu and associated silver and gold - It is a first time report of 107.60 m thick Cu mineralisation from the Alwar Basin of the North Delhi Fold Belt which includes a no. of lodes of 78.15 m x 0.35% Cu (at 0.2% cut-off) and 33.8 m x 0.65% Cu (at 0.5% cut-off).

Drilling in borehole KBH-2, which is further 185.0 m north of KBH-1 along the strike also intersected similar type of sulphide mineralization from 35.0 m to 225.0 m (190 m) with 0.2-0.5 % Cu (V.E).

### Iron Ore

- In Devadaribetta Range (NMDC block), Bellary district, Karnataka, which was explored during F.S. 2005-08, a Reconnaissance resource (334) of 8.20 million tonnes of iron ore (Hematite) with 57.37% Fe has been estimated.
- In Chhattisgarh, Prospecting stage (G-3) investigation initiated during F.S. 2007-08 for assessment of iron in Aridongri area, Kanker district as a sponsored item of Chhattisgarh Mineral Development Corporation Limited was completed after getting necessary forest clearance for drilling in the month of December 2010. A total inferred resource (333) of 10.01 million tonnes with a grade of 62.28% Fe has been estimated.
- Iron ore investigations are also continuing in the states of Rajasthan, Karnataka, Orissa, and Jharkhand.

### Manganese

- Prospecting stage investigation (G-3) initiated during F.S. 2009-10 was continued in Bonai-Kendujhar belt in the identified Damurda south block, Bolani south block and Bolani NE continuous Block of Kendujhar district in Orissa for resource assessment of manganese. The sub surface exploration so far carried out has identified mineralized zones over a strike length of 300m. The inferred ore resource estimated at 20% Fe cut off is about 0.152 million tonnes (333) with an average grade of 18.98% Mn (Resource figure with 30m strike length). The work is continuing.
- Investigations for manganese are being carried out in the states of Orissa, Maharashtra and Madhya Pradesh.

### Coal & Lignite

- During FS.2010-12, exploration for coal was continued in different Gondwana basins which includes Raniganj Coalfield and Rajmahal Master Basin of West Bengal, Ib-River and Talcher coalfields of Orissa, Mand-Raigarh, Hasdo-Arand and Tatapani-Ramkola coalfields of Chhattisgarh, Singrauli, Sohagpur, Johilla and PENCH Valley coalfields of Madhya Pradesh, Wardha Valley Coalfield of Maharashtra, Singrimari Coalfield of Assam and Godavari Valley Coalfield of Andhra Pradesh. The search for lignite resources has been given importance in the states of Tamil Nadu and Rajasthan. Reconnaissance and prospecting stage exploration is being carried out under promotional funding by MoC in East Coast lignite fields of TamilNadu and in the Nagaur South sub-basin belonging to West Coast Lignite Fields of Rajasthan.

- GSI has estimated coal resource of 2641.63 million tonne in the states of West Bengal, Orissa, Jharkhand, Chhattisgarh and Madhya Pradesh and 124.6 million tonne of lignite in Tamilnadu, Rajasthan and West Bengal during 2010-12 (as on 01 April, 2011).
- GSI has started Gas desorption tests in some of the boreholes in selected coalfields to generate base level data on Coal Bed Methane (CBM) for some selected coal seams at different depth levels using temperature controlled canister. CBM and related study were taken up during F.S. 2010-12 in three boreholes one each in Ib-River Coalfield, Talcher Coalfield and Mand-Raigarh Coalfield. In-situ gas content of collected coal core samples collected so far, ranges from 0.06 to 0.52cc/gm, being maximum in Ib-River Coalfield.

Beside these investigations, GSI has also taken up investigations for chromite, bauxite, limestone, Rare Earths, phosphorite, apatite, gypsum, glass sand, talc-steatite and fullerene. Investigations for these minerals are continuing and results shall be known after completion of the investigations.

### MISSION - III : GEOINFORMATICS

**GSI Net-Portal Project:** The GSI Portal received the Silver Award for 2010-2011 for the National Awards for e-Governance 2010-2011 under the category - "Best Government Portal". It also received the Best Public Choice award in the G2G category in the World 2011 Awards.

The GSI-NET Portal Project resulted in implementation of the following ICT components:

- GSI Intranet: The state-of-art robust secure, scalable, organization wide networking with inbuilt QOS features for information /data flow in the form of voice, data and video in single channel.
- LAN at all Regional / Wing / Operational Offices spread all over the country (37 locations).
- WAN (MPLS VPN) connecting all these offices.
- Enterprise Integrated Portal (EIP): A centralized, n-tiered web-based, cost effective Portal solution, which provides a single point of access to all the applications in the GSI Enterprise Application suite.
- Data Centre at Kolkata and Disaster recovery site at Hyderabad.
- The GSI Enterprise Application suite consisting of Information Portal, transactional application for back-office, scientific applications with map services and collaborative services :
- IP telephony and Video conferencing: Use of IP telephony all over GSI, and Video conferencing application deployed over the CHq, and Regional headquarters.

#### Information dissemination:

GSI is serving the following information through its Portal (<http://www.portal.gsi.gov.in>)

- Activities and Field Season Projects of GSI
- Products like Unpublished Progress Reports, Published maps (Geological Quadrangle Maps, District Resource Maps, etc), Publications (Records, Memoirs, etc.), DIDs, etc.
- 1:2 million geological and mineralogical map of the country and 1:1 million seismotectonic atlas as map services
- Fossil and meteorite repository
- Employee information

- Other topics of popular interest such as case studies, photo gallery, Indian Geology, Geotourism, etc.
- Official and transactional information such as budget, expenditure, claims, tour, leave, etc.

A Map service depicting 1: 50K geology of India is available over the intranet. The data is centrally stored in a multi-user geodatabase which is accessed by authorized users of GSI to load toposheet-wise geological maps. At present geological maps pertaining to 4756 sheets are available in the geodatabase.

### OCBIS Project:

8.18 Online Core Business Integrated System or OCBIS is envisaged to be an integrated system with suitable MIS and data workflow mechanism to facilitate proper execution of Core Business processes.

- The system will seamlessly integrate geoscientific and administrative processes / dataflow in Missions and support systems;
- It will integrate all available data in a spatial environment, allowing search and exploration using attribute-based and AOI based queries; will enable Geoscientists in field and laboratories to explore, observe, consult and make decisions using the spatial data service, which serves existing data in the form of maps, reports and publications;
- Integrate with the existing FSPMIS (Field season project management information system), LMS (Laboratory Management system) and HRMS (Human resource management system) and other transactional systems; enhance and / or re-engineer the existing information and MIS systems and establish linkages with the proposed system;
- Enable workflow based data collection, review, analysis, storage, report generation and dissemination; preserve all versions of data / documents pertaining to a field project since its inception to completion;
- Disseminate integrated MIS report through the Web Portal and through mobile devices and facilitate real-time collaboration and interaction among stakeholders

To achieve the above referred goals GSI has contracted NISG (National Institute of Smart Government). The broad Terms of Reference of NISG's work are as follows:

- Understand Data Content, Standards, Services, Information Requirements & Workflows, Understand Legal and Regulatory Framework, Stakeholder Analysis
- Current State Assessment and Gap analysis and To Be Requirements Planning
- Preparation of Functional Requirement Specifications (FRS) for OCBIS
- Preparation of Detailed Project Report (DPR)
- Prepare RFP Document for implementation of DPR

GSI will publish the RFP to select a System Integrator / Vendor (SI) for turnkey implementation of the total project (OCBIS) as outlined in the DPR. The Consultant will also assist GSI towards SI selection based on technical and financial bids as per published RFP.

Based on their studies since March 2011, NISG has submitted the Inception Report, AS-IS Assessment Report, Best Practice Survey Report, Capacity building Report, Solution Architecture, Gap Analysis Report and the Detailed Project Report.

GSI has submitted an EFC Memorandum for the OCBIS Project on 25th November 2011. The 'in-principle' approval of Planning Commission for the OCBIS Project is awaited.

## Portal applications:

GSI is having more than 34,858 metadata of unpublished reports till December 2011 and out of 4,905 (topo-sheets) Geological maps on 1:50,000 scale 4,756 maps have already been uploaded to portal.

## MISSION- IV: FUNDAMENTAL AND MULTIDISCIPLINARY GEOSCIENCES AND SPECIAL STUDIES

### Laboratory Studies, Research and Development

As a result of up gradation and 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, Analytical Chemistry etc. intensive laboratory studies were carried out to generate precise analytical database in consonance with the global trend and to keep pace with the research activities carried out in similar Surveys elsewhere. 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 as well as in STM and metallogenic projects.

GSI carried out several research projects with an idea to augment the mineral resources of the country. GSI has taken up research projects on PGE Exploration, polymetallic minerals, coal, gold exploration etc. and the scientists engaged in such research in collaboration with the exploration geologist has opened up new areas of interest. Other research work like stratigraphic correlation, palaeontology, experimental petrology shall also be pursued by GSI with equal zest as they broaden the horizon of understanding of earth sciences.

Most of the research projects under taken during the field season are being continued this year and details of the projects can be found in the Annual Report of GSI for the current year.

During the period from April, 2011 to December, 2011 a total no. of 1,39,558 NGCM & Non-NGCM samples have been analyzed for 10,03,336 no. of determinations.

### Specialized Investigations

#### Geotechnical Surveys

- Geological Survey of India has made commendable contribution at different stages of geotechnical investigations for the successful completion of large numbers of Water Resource Projects like hydroelectric, irrigation and river linking projects within and outside the country. Twenty-Nine items of geotechnical and engineering geological studies through 134 investigations has been 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 neighbouring countries.

#### Landslide Hazard Studies

- Landslide hazard zonation study on macro scale i.e. 1: 50,000/1:25,000 scale: carried out in the state of Arunachal Pradesh, Utarakhand and Himachal Pradesh. During the field season 550 sq km area was so far covered also Under item Rampur-Narkanda-Khab communication route, H.P., preparation of hydrogeological map covering 150 Sq km was carried out
- Landslide hazard zonation on meso scale i.e. 1:10,000/1:5000 scales of Shillong Town, East Khasi Hills District, Meghalaya was taken up.
- Landslide inventory: During the FS 2010-12 landslide inventory works has been carried out in the states of Maharastra, Karnataka, and Goa Inventory of landslides along Ghat Sections in

parts of Ratnagiri, Sindhudurg, Satara, Nasik, Thane, Kolhapur and Pune Districts, Western Maharashtra. So far 259 line km was completed.

- Site specific study of landslide: During 2010-12, 13 site specific investigation including monitoring items are being carried out in the states of Sikkim, West Bengal, Karnataka, Tamilnadu, Kerala, Goa. So far 2.24 sq km area was covered. Detailed site specific studies and concurrent monitoring of few selected landslides in the states of West Bengal, Sikkim, Tamilnadu and Maharashtra are taken up by Geological Survey of India in the FS 2010-12.
- Rapid response to suggest immediate measures in the event of landslide events: .During the current FS also Geological Survey of India has undertaken measures for immediate dispatch of expert team to the sites of distressing in the events of any major landslide events for an on spot evaluation and to suggest measures to content the distressing. The immediate findings at\re reported to reported to the concerned authorities.
- Landslide Hazard Information Management: During work taken up includes Incorporation of landslide data in the Standard Format from Investigation Reports and Development of database on FIRs, Landslide Reports and Landslide incidences.

### Earthquake Geology

- GSI undertakes the study of active faults (study of source region of earthquake) and seismic micro-zonation (site of interest) of urban agglomerations in various geological domains of the country.
- The work carried out under the Seismological Monitoring including detection, recording of earthquakes by the network comprising three Seismic observatories near Gangtok, Agartala, and Itanagar and release of quarterly bulletins and information to the respective regional offices, state administration etc.
- During the Field Season 2010-2012, six items of active fault mapping and DGPS based crustal deformation studies in the states of H. P, Assam-Arunachal. Maharashtra- M.P, West Bengal. Sikkim and A&N) and four items of seismic microzonation( Jorhat, Surat, Jalandhar and Vijaywada) were undertaken.
- The permanent GPS station at Lucknow (established by DST since 1999) is engaged in round the clock monitoring of GPS data. The data is supplied regularly to National GPS Data Centre, Survey of India, Dehradun for further processing/interpretation.
- The micro-earthquake investigation at and around the proposed “Tamanthi Hydroelectric projects, Myanmar” for NHPC was completed during the FS 2010-2012.
- Macro-seismic survey after Sikkim earthquake of 18th September 2011 and Sasan Gir earthquake of Gujarat of 20<sup>th</sup> October 2011 besides micro seismic activity in Kalgurki, Talewad and Malghan villages of Basavana Bagewadi Taluk, Bijapur District, Karnataka were also undertaken during the FS 2010-2012.

### Environmental Geology & Medical Geology

- GSI took up 17 items pertaining to Environmental Geosciences and related studies during F.S.2009-10 and 2010-12. These investigations include Environmental Geology (2 items), Medical Geology (5 items), Climate Change Impact and Fragile Eco-system (2 items), Glaciology (5 items) and 3 items on Syn-Exploration Baseline Data Generation (SEBDG) on geo-environmental aspects in connection with exploration for coal.
- The Medical Geology items taken up by GSI have direct bearing on society and GSI has been working for the last several years on Arsenic and Fluoride pollution in groundwater in the states of U.P., West Bengal and Rajasthan.

- Study of coastal processes has been taken up in Orissa.

### Glaciological Studies

- Detailed studies on the Hamta Glacier of Lahaul and Spiti were continued. Paleoclimatic reconstruction through monitoring of glacier retreat events in parts of Satluj valley, Kinnaur district, Himachal Pradesh has been attempted. Identification of signatures of palaeo-glaciation, change in climate, availability of water resources etc in Ganga Basin, Uttarakhand was carried out with the compilation of recession data on glaciers of Ganga basin. Updation of glacier inventory of Sikkim has been taken up and details of latitude, longitude, orientation, highest and mean elevation etc. were recorded.

### Arctic / Antarctic Studies

- GSI was inducted in the Arctic Expedition of National Centre for Antarctic and Ocean Research (NCAOR) in 2008. Since then, the item on parameterization of Glaciers in Northern Hemisphere to variations of Climate-Inter Annual and Intra Annual is being carried out by GSI to understand polar glacier teleconnection and the processes controlling these interactions.
- GSI has been participating in expeditions to Antarctica since 1981 and the major programmes undertaken include: geological mapping on 1:50,000 scale, thematic mapping for petrochemical, structural and geochronological studies; glaciological observations on advance / retreat of polar continental ice, studies on shelf ice for accumulation patterns; study of the glacial dynamics recording the movement direction and velocity of the polar ice sheet; ice core drilling and lake sediment coring for palaeoclimatic studies; GPR survey for plotting lake bathymetry, etc.
- A project entitled 'Palaeoclimatic and Magmato-Metamorphic history of Wilkes Land, East Antarctica: constraints from accessory minerals, Clay Mineralogy and Micropalaeontology in Oceanic Sediments' is being carried out in collaboration with Delhi University. So far 105 sediment samples from IODP, Wilkes Land Expedition - 318 have been analysed for clay mineralogy, 25 samples have been analysed for grain size distribution studies. Heavy mineral assemblages and SEM of quartz grains are also completed for top 50m sediments. These studies have given valuable insights into the provenance of these sediments, their mode of transport and depositional environment.
- A scientist from GSI participated in the XXX Antarctic Expedition as the Voyage Leader for the second consecutive austral season (2010-11) to supervise the construction of India's third Antarctic Research Station, "Bharati" at Larsemann Hills. He accomplished all the scientific and logistic tasks successfully as per approved plan and within the stipulated period. The scientist was also imparted training on the use of NONEX explosives as rock breaking technology at Johannesburg. He used this acquired knowledge in construction activities like rock breaking for carving out road, leveling of Helipad and main station site etc. in Larsemann Hills. The barren promontory at Larsemann Hills after the completion of expedition now has 13 tank containers, a world class helipad of 30 x 30 meters made out of pre-cast concrete slabs with most advanced fuel station, 400 meters of carpeted road and about 600 meters of pipeline to bring in fuel and sea water to station and take the refuse back to the sea after treatment. The excavation and levelling of 70 x 60 meters area for the station and the driving of more than 90 piles of depths ranging from 6 to 14 meters and each capable of bearing a load of 80 metric tons has also been accomplished.

## MISSION - V: TRAINING AND CAPACITY BUILDING

### Human Resource Development

- HPC has envisaged that the Geological Survey of India Training Institute (GSITI) at Hyderabad should be developed into a 'Centre of Excellence' for providing high quality cutting edge training/knowledge delivery with state-of-the-art facilities. Thus, the Institute has embarked on a programme of capacity building to raise the technical ability of departmental candidates, officers of various State Governments, students, research scholars and faculties from Universities and geoscientists from the private sector. Six Regional Training Institutes (RTI) have been operationalised at the six Regional Headquarters under GSITI. The Field Training Centres of GSITI located in different parts of the country (FTCs) shall be conducting field based courses on different themes of earth sciences. Six new FTCs namely at Kothagudem (Andhra Pradesh), Jabalpur (Madhya Pradesh), Saketi (Himachal Pradesh), Salem (Tamilnadu), Sukinda (Orissa) and Wajrakarur (Andhra Pradesh) have been established to provide training in different aspects of geoscientific studies in the areas known for their geological significance.
- Geological Survey of India Training Institute conducts training in Advanced, Refresher, Induction, International and special courses as demanded by the mineral sector. For the FS 2010-12, 114 items, in different disciplines, are being implemented. Of these, 22 items are being conducted by the Mission Headquarters which include 3 International courses for the participants covered under Indo-Africa Forum Summit, 8 Induction Level Orientation courses- this includes 3 completed courses i.e. 33<sup>rd</sup> OCG (Spillover course of FS 2009-2010), 34<sup>th</sup> OCG and 5<sup>th</sup> OCGP, and two other in progress i.e 35<sup>th</sup> OCG, 6<sup>th</sup> OCGP, the other induction level courses include 8<sup>th</sup> and 9<sup>th</sup> OCC and 2 Orientation courses, one each for newly recruited Engineers and Administrative Officers of the Department. The remaining 10 are specialized courses, which includes 2 courses to be conducted in collaboration with ISRO. Till December 2011, 61 FSP programmes were completed. 58 Outside FSP programmes that were conducted as per the request of various offices and divisions that include E-Governance, NGCM training, Women empowerment, etc.
- GSITI has been given affiliation by Osmania University, Hyderabad for post -P.G. Diploma course in Geoinformatics in Earth Science.



Fieldwork by Orientation Course trainees around Ramapuram, Anantapur District, Andhra Pradesh

### COLLABORATIVE PROJECTS WITH OTHER ORGANISATIONS

The following programmes, State-wise, have been accommodated on the basis of the suggestions, recommendations and requests made by various stakeholders in the Annual Programme of GSI 2010-12:

#### MADHYA PRADESH

1. Detailed prospecting for phosphorite in Piploda Block and Dhanpura-Khatama Block, Jhabua District, Madhya Pradesh. One officer (geologists) from DGM, MP will be associated with the project.

#### MAHARASHTRA

- Investigation of manganese ore in Parseoni extension area, Nagpur dist., Maharashtra (E-I stage) (continuing)

## ANDHRA PRADESH

- Investigation for possible fullerene occurrence within carbonaceous tuff of Mangampet Baryte prospect and demarcation of carbonaceous tuff bearing areas for prospective drilling work around Mangampet, Kadapa District, Andhra Pradesh, Karnataka
- Preliminary investigation for limestone west of Nandikotkur, Cuddapah Basin, Kurnool District, Andhra Pradesh. (2009-12)(G-4).

## KARNATAKA

- Investigation of the iron ore resources in selected freehold areas in Kenkeri, Melanahalli, Guruvapura, Kempanahalli, Dasudi, Kandikere Blocks and adjacent areas in Hosadurga Taluk, Chitradurga District, Karnataka.(2010-12) (G-4).
- Preliminary investigation for PGE Group of minerals in mafic-ultramafic rocks of Nuggehalli Schist Belt, Hassan District, Karnataka.(2010-12)(G-4).
- Examination of SMS Grade limestone for Alkali content around Jalikatte, Lokapur and adjoining areas, Bagalkot District, Karnataka. (2010-12)(G-4).

## KERALA

- Evaluation of relict sand body off Shertallai, Kerala
- Evaluation of relict sand body off Ponnani, Kerala

## TAMIL NADU

DGM, Tamil Nadu would like to collaborate with GSI (regular items of GSI in Tamil Nadu)

- Electrical resistivity surveys along the coast between Puducherry and South of Chidambaram up to Coleroon River, Tamil Nadu

## ARUNACHAL PRADESH

- Photogeological interpreted Mapping in parts of Dibang valley, Arunachal Pradesh.
- Landslide Hazard Zonation of a 2 km wide strip in the catchment area for Dibang Multipurpose Project, Lower Dibang valley, Arunachal Pradesh.

## MEGHALAYA

- Mesoscale Landslide Hazard Zonation of Shillong town, East Khasi Hills district, Meghalaya.

## SIKKIM

- Reappraisal for the basemetals and gold in Chakung-Jugdum areatoposheet no 78A/4 & 8 covering parts of West District, Sikkim(G-4)
- Updating the inventory of glaciers in Sikkim Himalaya.
- Detailed geotechnical investigation of some important landslides of Sikkim.

The landslides proposed to be taken for detailed geotechnical investigation: Km 5.30 (Namok) slide on Rangrang -Dikchu Road; Km 72.10 (Lantakhola) slide on Gangtok -Chungthang Road; Km 78.50 (Mayang Chu) slide on Gangtok -Chungthang Road; Km 87.50 (Theng) slide on Gangtok - Chungthang Road; Manvir Colony(1.9) on Indira Bye pass; Km 24 on JNM

## HARYANA

17. Preliminary assessment of gypsum in parts of Hissar and Bhiwani districts, Haryana. (G-3)(2010-12).

#### HIMACHAL PRADESH

18. Specialized thematic mapping of Upper Krol for tracing of limestone/dolomite bands
19. Search for quartzite horizon suitable for glass industry (glass sand) in Rampur Group of rocks, Distt. Shimla & Kulu, Himachal Pradesh (G-4).
20. Geoenvironmental impact assessment of mining in the Beas and Pabbar riverbeds / terraces for sustainable exploration of minor minerals (53E/1,2,12,16; 52H/4).

#### UTTARAKHAND

21. Investigation for gold and associated mineralization in Lameri-Ratura area, Rudraprayag district, Uttarakhand (G-3 Stage) (2010- March, 2012).

#### JAMMU & KASHMIR

22. Detailed investigation for lead-zinc deposit of Buniyar area, Baramula district ,J & K, (G-4 stage) (2010- 2012).

#### GUJARAT

23. GSI will continue to provide technical guidance for Kachchh geochemical mapping project to be carried out by GMRDS / CGM, Govt. Gujarat.

#### RAJASTHAN

24. Regional assessment of low-grade phosphorite occurrences of Kalinjara, east of Sallupat, Banswara district, Rajasthan.
25. To provide technical guidance for Geochemical Mapping Project to be carried out by DMG, Govt. of Rajasthan, (under MoU between GSI, DMG & RSMML, Govt. of Rajasthan) - geochemical mapping of toposheet 45L/1 to L/13 & L/16, 45G/6 to G/16 covering parts of Chittaurgarh Pali, Pratapgarh, Rajsamand and Udaipur districts.

#### BIHAR

26. Investigatgion for gold in Gosari-Ghutwe Block of Sono area, Jamui district, Bihar (G-3) (2010-12).

#### JHARKHAND

27. Appraisal for iron ore around Silpunji-Kantoria Block, West Singhbhum District, Jharkhand (G-4) (2010-2012). One officer (geologists) from DGM, Jharkhand will be associated with the project.

#### WEST BENGAL

28. Investigation for talc-steatite around Lapcha Basti and Singla in the extensiuon areas of Gok-Karmi of Darjeeling district, West Bengal (G-4) (2010-12).

#### OTHER PROJECTS

29. Collaborative participation of SAC, Ahmedabad and GSI - Use of hyperspectral data for the search of mineralized provinces in the Precambrian terrain of eastern and northern Gujarat.
30. To carry out geomorphological and lineament mapping of India on 1:50,000 scale with three years duration in collaboration with NRSC under NNRMS-SC (G) using digital data.

31. Seismic Hazard/ Microzonation of Surat Town (2010-2013) in collaboration with ISR, Gandhinagar

### Other Activities

- GSI took part in different exhibitions / book fairs essentially to interact with and enlighten the general public on various aspects of geoscience.

International Commercial Projects:

India- Myanmar (through NHPC)

A MoU (geophysics part) between GSI and NHPC Ltd. for the micro-earthquake studies of Tamanthi Project, Myanmar was signed on 24<sup>th</sup> December, 2010. As the follow-up action, three geophysicists from CGD, Kolkata undertook micro earthquake studies related to the proposed Tamanthi (1200MW) Project. The project was completed.

### Bhutan and Nepal

As per the signed agreements with CWC (for Bhutan) and with JPO-SKSKI (for Nepal), the GSI officers visit Bhutan and Nepal for carrying out geo-technical work related to hydro-electric projects.

## SCIENCE & TECHNICAL SUPPORT SYSTEM

### IT Infrastructure & Connectivity:

GSI has established an organization-wide IT infrastructure in the form of a DC & DR with network connectivity based on MPLS (Multiprotocol Label Switching) VPN technology that connects its offices spread over the country with hub and spoke technology. The network is capable of transferring data, voice and video and provides different services to its employees through GSI Portal as gateway which includes GIS Services and Transactional applications. The portal is available for public access and is the instrument for information dissemination for GSI. IP Telephony and Video Conferencing have been used in the GSI Intranet for office communication and collaboration.

The ICT infrastructure at GSI comprises of the following: -

- GSI Intranet (LAN and WAN)
- Data Center (DC) at Kolkata
- Disaster Recovery Center (DR) at Hyderabad
- IP telephony and videoconferencing infrastructure
- Desktop Infrastructure

### Future Roadmap for IT in GSI:

The future IT Roadmap in GSI will imbibe the Mission mode structure of GSI and provide systems and applications catering to Missions and Support services and the overall information delivery sub-system. The non-core services of GSI will be dealt in two broad sections - ICT infrastructure services (essential for both core and non-core business) and e-Governance services. The ICT infrastructure services section include the critical components such as enterprise portal, content management system, communication channels, security and ICT services like SOA governance and performance management. The e-Governance services include financial management system, HRMS, material management and e-procurement. The support services will

also include biometric attendance system integration as well as other e-Governance services like Rajbhasha and vigilance.

This future IT infrastructure will be achieved through the OCBIS Project which will use a service integration framework. Service Oriented Architecture (SOA) strategy at the enterprise level is a fundamental requirement for the OCBIS application, as this will help GSI enhance the flexibility of the technical and scientific processes along with reducing IT costs. Despite being an IT architectural approach, this endeavour will combine people, process and technology to establish a technology framework which will serve the day-to-day operations across GSI and also re-use components to accommodate ongoing needs, change and growth of GSI.

Following are some of the characteristics of the future IT architecture of GSI:

- Adoption of open standards
- Alignment of GSI technical processes with IT
- Integration of functions and processes across GSI
- Enablement of agility, flexibility and responsiveness
- Framework for integrating external and legacy applications

At its core, SOA will allow the various GSI application functionalities to be exposed as loosely coupled services to other applications (and vice versa), providing exchange of information using a standards-based approach.

The key to ICT enablement in any organization, especially in organizations handling large volumes of data on a daily basis, is the implementation of efficient data center and data recovery center. A Tier 2 Data Centre will be established in the Central Headquarters, Dharitri Building, Salt Lake, Kolkata. The DR at Southern Region office of GSI, Hyderabad will have enhanced functionalities and capacity. Additionally, the infrastructure currently available at CHQ will be fully utilized to render a near site node for synchronized zero data loss replication, development center and QA environments. The DC/DR/NS architecture has been planned to ensure loss-less transmission and synchronization of data.

### Analytical Chemistry and Chemical Laboratory Network

There are 21 Chemical Laboratories in GSI functioning in six Regions with its head quarter at Kolkata and rendering key supportive role in all geo-scientific activities. Chemical analytical data is utilised in the field of mineral exploration, PGE investigations, geo-environmental studies, fundamental research etc. by way of providing highly precise and accurate analytical data from percentage to ppb/ppt level using conventional as well as modern state-of-the-art analytical instrumentation techniques. With the induction of NGCM programme in GSI in the year 2001 and for its successful completion in a time bound manner with the aim of providing geochemical Maps to supplement geophysical and geological maps for a variety of uses, chemical laboratories play vital role. In addition to mineral exploration as well as other investigation works, chemical laboratories are dedicated for generation of highly precise and accurate analytical data for the generation of interim report of NGCM programme. The analysis of the 61 elements are being carried out by several instrumental techniques e.g., XRF, ICPMS, DMA, AAS etc. and for the simplicity of analysis, these 61 elements have been grouped into 9 packages. These are (a) Package A (26 elements-XRF), (b) Package B (Au -GFAAS), (c) Package C (Li & Cs-FAAS), (d) Package D (As, Sb, Bi & Se-VGA) (e) Package E (F-ISE), (f) Package F (Ag & Cd-GFAAS), (g) Package G (Hg-DMA), (h) Package H (22 elements-ICPMS) (i) Package I (Pt & Pd-FA cum GF AAS). After rigorous R & D works, methodologies have been developed and standardized for Package A-H by the chemical division to attain the stipulated LLD values as per

NGCM programme. For Package I, R & D activities are still going on to achieve the targeted LLD values.

Chemical Laboratory Networking is a PAN India activity covering all the laboratories with an objective to provide an adequate, effective and more coordinated service delivery while day-to-day operational management, overall planning, procurement of costly equipments, closer monitoring of laboratory equipment usage, analytical output & operating cost among the different chemical laboratories of GSI. Presently all the 21 chemical labs except J & K and Mangalore are connected with LAN facilities through which generated analytical data are directly forwarding with the help of GSI portal system.

### Laboratory Network (Other than Chemical)

- Electron Probe Micro Analyser (EPMA) instruments are in operation at Central Petrological Laboratory, Kolkata, Petrology Division Hyderabad, EPMA Lab Faridabad and PPOD, Bangalore.
- The Scanning Electron Microscope (SEM) laboratories are operating in Kolkata, Hyderabad, Nagpur and Lucknow respectively.
- Petrological Laboratories are at Headquarters, Kolkata and in each Region, in Mission-1A (MCS), Mission-IIB (Natural Energy Resource-NEnR) and other State-based operational units, to cater to the needs of the various disciplines of Earth science and also to carry out research on fundamental and applied aspects of igneous, sedimentary, metamorphic petrology, ore-mineralogy, coal petrography and clay mineralogy. Studies of meteorites are also being carried out in Central Petrology Laboratory, Kolkata. Most of the Regions and Mission laboratories are equipped with Advanced Research Polarizing Microscope with photographic attachment, digital camera and image analysis system.
- The Gem Testing Laboratory of GSI at Central Headquarters, Kolkata provides commercial service for identification, authentication and certification of the gemstones. Gem Testing facilities are also available at Regional Petrology Divisions of different States. Gem testing facility has been started in the Petrology Division, W.R.
- Experimental Petrology laboratory was established at Central Petrology Laboratory, CHQ, Kolkata in 2001 and since then three equipments have been installed. These are 1) Extra Thermal Kanthal furnace (up to 1750°C) used for preparation of glass. 2) Graphite furnace for 1atm melting experiments, and 3) Hydrothermal Instruments for hydrothermal experiments (installed in 2006).
- Mineral Physics Laboratories are located in all the six Regions of GSI apart from the one at Kolkata (CHQ) and equipped with single crystal X-ray diffractometer, thermal analyzer and infrared spectrometer.
- Fluid inclusions study is being carried out at PPOD, Bangalore, Central Petrological Laboratories, Kolkata and Regional Petrology Division, Lucknow. In these laboratories the heating-freezing experiments were done up to 600° C. The instrument is attached with software to study the various parameters of heating-freezing Experiments.
- Palaeontological Laboratories are at Central Headquarters, Kolkata and in each Region, and in Mission-1A (MCS), Mission-IIB (Natural Energy Resource) to cater to the needs of the various disciplines of paleontology and other research on fundamental and applied geosciences. Most of the laboratories are equipped with Advanced Research Microscopes.
- The Geochronology and Isotope Geology Laboratories at CHQ, Kolkata is only one of its kind in GSI and has been carrying out radiometric dating of hard rocks by U-Pb, Sm-Nd and Rb-Sr

systematics in Thermal Ionisation Mass Spectrometer (TIMS) and 14C dating of quaternary sediments by Liquid Scintillation Counter.

### Geophysical Laboratories

The physical property measurement laboratory in Southern Region is equipped with Pulse Magnetiser, Minispin Spinner Magnetometer and Shielded Demagnetizer along with other measurement units and carried out density, magnetic susceptibility and natural remanent magnetization of rock samples from different field areas. A total of 138 rock samples were collected from Anantpur area, Andhra Pradesh for measurements of density and magnetic susceptibility. Central Region is equipped with digital Spinner magnetometer (JR-6), AF demagnetizer. Northern Region has carried out Magnetic Susceptibility and Density measurements of 11 rock samples from 8 sites falling under 54K/8 & 12. The Physical property measurement laboratory in Central Geophysics Division carries out seismic wave velocities ( $V_p$  and  $V_s$ ), density, Thermal conductivity and magnetic susceptibility measurements of rock samples.

The major Laboratory equipments acquired and installed and other major purchases in GSI during the Financial Year (FY) 2011-2012 is tabulated at Table: 8.3.

**Table: 8.3**  
**Expenditure Incurred Under M & E Head in the Financial Year 2011-12**  
**(Upto December 2011)**

Desription of Stores	Actual Expenditure ( ` in Lakh)
Triplex single acting skid mounted pump	4.46
HX Casing	68.34
NX Casing	52.07
BW R/H Threaded internally upset ends Drill Rods 1500 Nos.	107.25
Multi Electrode Resistivity Agency commission	1.40
AMC for thermal Ionization Mass Spectrometer	2.98
EPMA SX-100 Tech & Logistic Serial charges	53.72
Multi Parameter Bore Hole Unit Agency Comission	2.88
NW -R/H threaded Drill Rod	10.93
Duplex double acting skid mounting pump	6.11
Triplex single acting skid mounted pump	1.88
Direct Solid Mercury Analyser	3.30

IP Resistivity Instrument 3 KW)	235.42
FIAS 100 SYSTEM(Flow injection for Atomic Spectrometry) for existing parking elmer model PE-700AS	7.70
Rotary core Drilling flush jointed Right Hand threaded NQ Drill rods x 3 mtrs. Long = 3000 NOS	65.50
Duplex double acting skid mounting pump	2.57
Triplex single acting skid mounted pump	1.13
Custom duty Micromill	1.60
Heavy Duty skid mounted Diamond Core Drill 1000 mtrs. Capacity. - 5 Nos.	69.53
Sub-boiling distillation unit	6.24
Custom clearance for FIAS and IP Resistivity	28.26
Spares for thermal ionization Mass Spectrometer	30.53
Custom duty for clearance of consignment	21.39
Regional Purchase other than CHQ	1853.49
2nd Installment payment for OGRV	7199.00
TOTAL	9837.68

## ADMINISTRATIVE SUPPORT SYSTEM

### Human Resources

A rational and comprehensive approach on HRD necessitating review of mode of induction, training, motivation including career progression and manpower deployment is receiving constant attention. Considering the present level of manpower deployment vis-à-vis the envisaged intensification and diversification in scientific programmes, a process of bulk induction in all the S & T streams has already been initiated from 2006 with the approval of the Government and it will continue till the optimum strength is attained. Statement showing strength/Incumbency in Group-A posts in various Streams in Geological Survey of India is listed in TABLE 8. 4. Periodic exposure of scientific and technical professional to emerging developments in techniques and concepts in various domains of earth science activities is needed from both within and outside the country.

During the F.S. 2010-12 (Oct. 2010 to till Dec. 2011), a total of 2867 nos. of personnel has been trained (From GSI: 2514; From States: 117; From other organizations: 198 and From Abroad: 38).

**Table-8.4**  
Statement showing strength @ / incumbency in Group 'A' posts in various streams in Geological Survey of India as on 31.12.2011

Stream	JTS		STS		JAG		JAG [[including JAG (NFSG)]]		SAG		HAG		APEX		TOTAL	
	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
Geology	1086	779	978	446	-	-	639	288	69	18	13	1	1	-	2786	1532
Geophysics	264	113	190	50	-	-	91	21	9	2	1	-	-	-	555	186
Chemistry	250	117	171	24	-	-	80	25	8	1	-	1	-	-	509	168
Engineering	38	23	42#	27#	-	-	7	4	3	2	-	-	-	-	90	56
Personnel / Administration	28	14	12	7	6	5	3	2	2	1	1	-	-	-	52	29
Finance	15	1	8	3	9	1	-	-	-	-	1	-	-	-	33	5
Stores	-	-	7	6	-	-	2	1	-	-	-	-	-	-	9	7
Library	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Survey	20	-	10	-	1	-	-	-	-	-	-	-	-	-	31	-
Civil Engineering (SE Construction)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Official Language	7	-	1	-	-	-	-	-	-	-	-	-	-	-	8	1
Law officer	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Vigilance	-	-	1	-	1	1	-	-	-	-	-	-	-	-	2	1
Stenography	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
<b>Total:</b>	<b>1713</b>	<b>1047</b>	<b>1420</b>	<b>564</b>	<b>17</b>	<b>7</b>	<b>822</b>	<b>341</b>	<b>91</b>	<b>24</b>	<b>16</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>4080</b>	<b>1985*</b>

\* as on date this post is common to Geophysics, Chemistry & Engineering Stream , presently it is filled by a Chemistry Stream officers.

# includes posts at NFJAG.

@ Manpower strength operationalised in terms of GSI Notification No. 8630A/HPC/GSI/2011 dated 29.12.2011.

### Drill Core Repository

Collegium headed by, DDG, Mission-III had examined and submitted their recommendations for finalisation of location of National drill core library either at Nagpur or at Hyderabad. The members of the Collegium critically examined and made a comparative assessment of the availability of space, infrastructure facilities and future scope for expansion available both in Nagpur and Hyderabad and recommended for the location and establishment of National Drill core Library (NDCL) at Hyderabad. The administrative control of the NDCL will be with HOD, SR and the overall technical control shall be with the DDG, PSS, CHQ, GSI. The recommendations of the Collegium have been approved by DG, GSI.

The policy document for establishing NDCL with respect to core acquisition, selection criteria, preservation and core library management system has been finalized and submitted to DG, GSI for his kind approval. The tentative cost estimate for establishing NDCL at Hyderabad is being worked out.

Besides Each Regional Heads has been requested to give cost estimates for upgrading the Regional core Libraries. The process of establishing NDCL and upgrading Regional drill core library shall be initiated once the final approval is accorded for the proposed XII Plan document

### Geological Monuments & Parks

Undertaking the responsibility of protection and promotion of geological monuments, GSI has declared 27 such sites, located in various parts of the country, as National Geological Monuments. To provide a unique spectrum of geo-heritage and geo-diversity for showcasing geological attractions that can provide an insight into the past formations of the subcontinent, its orogeny, palaeo-environment and exotic collection of palaeo-flora and fauna, for public education, recreation and sustainable economic development.

A project being promoted by Tourism Dept., Govt. of Sikkim to set up a fossil park at Mamley, South Sikkim where rare one billion year old Stromatolite fossils occur. GSI will also help to set up a geological museum in Sikkim where fossils and rock samples etc. from various parts of India will be displayed. GSI will also create a Rock Garden of relevance to the state of Sikkim besides providing two life-size Dinosaurs models. A fossil park for fossil wood occurring within Tipam Formation of Tripura has also been proposed.

### Museums

Over the course of the last 160 years, innumerable specimens have been collected from all over the Indian subcontinent and abroad. GSI has systematically catalogued fossil, rock, mineral and meteorite collections. The foreign specimens have been preserved for comparison. The large numbers of these valuable specimens are preserved in the galleries of the Indian Museum and in the Central Headquarters of GSI. The meteorite collection is preserved at the Central Geological Laboratories, Kolkata. The four geological galleries of GSI at the Indian Museum, Kolkata are Siwalik Fossil Gallery, Invertebrate Fossil Gallery, Rock & Mineral Gallery and Earth & Meteorite Gallery.

## POLICY SUPPORT SYSTEM

### Planning and Monitoring

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 SGPB, CGPB committees, advisory board of allied organisations and undertakings in the Annual Programme etc. One of the most important functions is the formulation of draft annual programme April 2012 -March 2013 where it keeps nation's geo-scientific requirements in consideration and put the set policies into monitored implementation. The Monitoring Divisions of the Operation monitored the items in various mineral commodities, mapping and specialized investigations of F.S. 2010-12. 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. Planning Division looked after task force activity, prepared budget estimates of F.Y. 2011-12 as well as the annual plan of GSI 2012-13, budgetary managements of F.Y. 2010-11 and F.Y. 2011-12 and

modernization aspects while Parliament Cell provided information and supplementary details to MoM on parliament questions.

PSS-P&M Divisions prepared several documents/ material including for Annual Plan, Briefing Book-GSI, Performance for Parliamentary Standing Committee, Annual Report and Quarterly Progress Review Meetings, review of base documents of CGPB Committees along with material for periodic returns to MoM e.g., Annual Action Plan of MoM, Cabinet DO-Thrust Area, monthly DO to the Secretary (Mines), monthly summary of work for all the programmes, etc. The Division is also monitoring implementation of annual programme 2010-12 in different Regions.

Offices of the CGPB Secretariat, Science Policy & Coordination, Geoscience partnership, International Co operation and Commercial Operation Divisions are now functional in the 'DG's camp office in Delhi', as suggested by HPC. 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.

Annual Report of GSI 2010-2011 has been published as Records of the Geological Survey of India Volume 145, Part 9 and released and distributed during the 49th CGPB meeting at New Delhi. The wide spectrum of GSI's work has been brought out in the Annual Report 2010-2011.

### Central Geological Programming Board [CGPB]

Since the creation of the CGPB Secretariat, the 45<sup>th</sup>, 46<sup>th</sup>, 47<sup>th</sup>, 48<sup>th</sup> and 49<sup>th</sup> CGPB meetings have been organized successfully. On each of these occasions, except the 48<sup>th</sup> CGPB, two-day exhibitions were also held depicting various themes of GSI. The 50<sup>th</sup> CGPB meeting was held on 2<sup>nd</sup> and 3<sup>rd</sup> February 2012.

The 48th CGPB was held on 3-4 Feb 2011 at Vigyan Bhawan New Delhi. However, due to certain unavoidable circumstances, the exhibition proposed to be held on the theme of Geoinformatics was called off.

The 49<sup>th</sup> CGPB meeting was held on 24-25 August 2011 at Indian Council of Agricultural Research (ICAR), Pusa. The two-day exhibition held during the meeting showcased the activities of GSI and its sister organizations on the theme of 'Geophysics'. FUGRO, a private organization, also participated in the exhibition.



Shri S. Vijay Kumar, the then Secretary (Mines) and Shri S.K. Srivastava, Additional Secretary (Mines) inaugurating Exhibition during 49<sup>th</sup> meeting of Central Geological Programming Board (CGPB) held on 24-25 August, 2011 in New Delhi

### 50th CGPB Meeting

In the CGPB Meeting held on 2nd -3rd February, 2012, the following important issues were taken up:-

- The Field Season Programme 2012-13 was approved taking into account the proposals received from State Governments and other stake holders.
- Proposals for carrying out heliborne surveys in various States on request made by State Governments.
- Special assistance to DGMs of NER by providing equipments and instruments, training and capacity building of officers by organizing customized and specialised training courses.
- Elaborate discussion on implementation procedure to be adopted for online Tenement Registry and Geo-referencing of lease boundaries.
- Establishment of National and Regional Core libraries following international best practices. Also, establishing Geoparks at suitable places in the country.
- Issues relating to constraints in obtaining forest clearances for mineral exploration and MoEF stipulation on drilling density for mineral exploration/prospecting in forest areas.
- Issue of adopting UNFC and JORC system of reporting of Mineral resources.



Shri Dinsha Patel Hon'ble Minister of State (I/C) for Mines inaugurating the Exhibition during 50<sup>th</sup> meeting of CGPB on 2<sup>nd</sup> February, 2012. Also, seen in the picture are Shri Viswapati Trivedi Secretary (Mines) and Shri S.K. Srivastava, Additional Secretary (Mines)

### Finalization of Base Documents of CGPB Committees

As decided during the 47<sup>th</sup> CGPB, the Base Papers, prepared by the 12<sup>th</sup> CGPB Committees, prior to their circulation were to be vetted by CHQ. Accordingly, the CGPB Secretariat got the Base Documents vetted by the CHQ and thereafter, sent them to the Ministry for approval. The Ministry, subsequently, directed the CGPB Secretariat to get the Base Documents peer-reviewed by external subject experts. The CGPB Secretariat, in consultation with the Conveners of all the 12 Committees coordinated the peer-review of the Base Documents.

The Secretariat has already received the peer-reviewed Documents in respect of three committees, and has been informed that the rest of the Base Documents are in the process of finalization.

## CGPB Committee Meetings

As a matter of convention, the CGPB Committees hold their meetings on their respective themes prior to the main CGPB so that their recommendations are discussed in the main forum. The 12 themes identified by the HPC are Ferrous Minerals, Precious Metals and Minerals, Non-Ferrous and Strategic Minerals, Industrial and Fertilizer Minerals, Energy Minerals and Resources, Marine Geology and Exploration and Coastal Geoscience, Airborne Survey and Remote Sensing, Geology and Mineral Resources of NER, Geoscientific Investigations, Fundamental and Multidisciplinary Geosciences, Geoinformatics and Data Management and Geoscience for Sustainable Development.

Accordingly, the CGPB Committees held their 4<sup>th</sup> and 5<sup>th</sup> meetings prior to the 48<sup>th</sup> and 49<sup>th</sup> CGPB meetings respectively. The wide range of membership in these meetings brought to the fore various issues of national and regional significance for discussions. Various projects in which a collaborative approach could be worked out were also discussed. These collaborations include those with various Central Ministries, State govts., institutes, universities etc.

Some of the major developments reported during the above meetings are as follows:

- (i) GSI and MoES have agreed for finalization of Draft Agreement on joint implementation of comprehensive swath bathymetry as per NMP-2008.
- (ii) The MoU between GSI and TERI on Carbon Sequestration, Geothermal Energy Resource Development and Collaboration on related Geoscientific Data Sharing has been finalized and approved by MoM. However, TERI has requested for enlarging the scope of data sharing in the MoU.
- (iii) With a view to steering general geo-scientific activities of MoM/GSI in line with national geo-scientific priorities and GSI's Vision, a Geo-science Advisory Council (GAC) has been constituted. GAC consists of representatives from MoES, S&T, MoEF, DAE and Planning Commission. Meanwhile GAC held its first meeting in September 2011 at ICAR, Pusa.

## SGPB Meetings

Between the 47<sup>th</sup> and 48<sup>th</sup> CGPB, State Geological Programming Board meetings were conducted by the States of Assam, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. The meetings discussed proposals for Field Season (FS) 2010-11 and 2011-12 and also analysed the work done pertaining to FS 2010-2011.



Shri Dinsha Patel, Hon'ble Union Minister of State (IC), Ministry of Mines, paid a visit to the petrology section of the museum at the GSI, Lucknow Office on 16th November, 2011

DGM, Gujarat approved several proposals related to detailed Mapping and Exploratory Drilling schemes. DGM, Haryana emphasized the need for investigations of strategic minerals like copper in Haryana.

Between the 48<sup>th</sup> and 49<sup>th</sup> CGPB, State Geological Programming Board meetings were conducted by the States of Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Mizoram, Nagaland, Orissa,

Tamilnadu and West Bengal held their SGPB meetings. The meetings took stock of the progress of work pertaining to FSP 2010-11 and discussed new proposals for FSP 2011-12.

Beside these State Geological Programming Board meetings two bilateral meetings were also held between Geological Survey of India and Uttarakhand State Government and between Geological Survey of India Jammu and Kashmir State Government.

After 49th CGPB, State Geological Programming Board meetings were conducted by the States of Maharashtra, Orissa, Kerala and Sikkim and one bilateral meeting was held between Geological Survey of India and Uttarakhand State Government to review the progress of collaborative mineral investigation programme at Ratura, Rudraprayag district and to discuss the issue of geotechnical assessment of 500 villages affected by natural disaster.



Accumulation Zone of Milam Glacier, Pithoragarh, Uttarakhand

Source - GSI

## International Cooperation

International activities by Geological Survey of India (GSI) with various foreign governmental organisations/ scientific agencies has been continued by GSI through collaborative and bilateral exchange programme in geoscientific projects, participation in international seminars, symposia, workshops, advanced foreign training programme and in Indian Scientific Expedition to Antarctica and Arctic region. The Ministry of Mines & GSI, in order to share expertise, develop national & international partnerships and promoting geoscientific activity, has entered into MoUs with various organizations and countries. GSI has also organised training programmes for geologists of the Government of Afghanistan and different African countries.

## International Geoscience Programme (IGCP)

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. The International Division, GSI, acts as the Secretariat of the INC and with the Director, as 'Member Secretary' of the INC. Every year a brief account of the activities of the ongoing IGCP projects in India is brought as 'IGCP Newsletter'. At present there are fourteen (14) INC members, from leading Indian scientific organisations/institutes, which include AMD, NGRI, ONGC, WIHG, FIMI 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 projects proposals for future implementation.

GSI is the accredited nodal agency for IGCP activity in India and so far India participated in 101-IGCP Projects out of which 8 are ongoing. The various IGCP Projects deal with geological

problems of global as well as regional significance taking into consideration the various geological, geochemical, geophysical parameters, tectonism, metallogeny, environment etc., in order to obtain in-depth understanding of the process involved in a regional perspective.

### Training, Seminars, Symposia Etc.

Twenty-seven (27) officers from GSI attended International Training Programme in India and abroad and twenty-nine (29) officers participated in International/ National seminars/ symposia/ workshops/ conferences/Expert members, etc during the period from April to October 2011.

Apart from above programmes, Geological Survey of India participates regularly in PDAC - International Convention, Trade Show, and investor's exchange, Canada and Mining Indaba, South Africa.

GSI continued its interactions with other countries to explore possible bilateral cooperation and collaborative programmes. Details of MoU and activities there under are as follows:

### BILATERAL COLLABORATIVE ACTIVITIES

GSI continued its participation in bilateral cooperation and collaborative programmes with other countries on several geoscientific arenas for mutual benefit. Ministry of Mines as well as GSI has entered into MoU with different countries in various ambit of geosciences.

#### MoU between GSI and other countries

##### 1. India-Netherlands (Project: INDIGEO)

Since 1999, GSI entered into a collaborative Project: INDIGEO with the International Institute of Geo-information and Earth Observation (ITC) along with Maastricht School of Management (MSM) of Netherlands and the Association of Exploration Geoscientists (AEG) with the objective of Institutional strengthening and Human Resource Development in the application of Digital techniques in GSI and other Earth Science Institutes in India.

GSI entered into a collaborative Project: INDIGEO-2 on 28<sup>th</sup> July, 2004 with the International Institute of Geo-information and Earth Observation (ITC) along with Maastricht School of Management (MSM) of Netherlands and the Association of Exploration Geoscientists (AEG) with the objective of strengthening the capability for application of digital methods in Geophysical, Geochemical and Geological mapping at the national geoscientific institutions of India.

#### Research/ Training on Landslide Hazards

As part of the collaborative study, a MoU was signed among GSI, NRSA and ITC for the Ph.D Programme with duration of 3½ to 4 years (partly in India and partly in the Netherlands) for three scientists. Under the programme, S/Shri Saibal Ghosh, Senior Geologist, Eastern Region, Kolkata and Pankaj Jaiswal, Senior Geologist, Southern Region, Hyderabad have been nominated by the Director General, GSI respectively for carrying out research work on 'Use of New Earth Observation Techniques for Landslide Hazard and Risk Assessment' in Himalaya and Nilgiri areas. They have completed qualifier phase (at ITC), Phase - I (in India), Phase - II (at ITC), Phase - III (in India), Phase - IV (at ITC), Phase - V (in India) and Phase - VI (at ITC) of the research work. S/Shri Saibal Ghosh and Pankaj Jaiswal had been conferred upon the degree of doctor at the University of Twente (ITC, the Netherlands) on 5<sup>th</sup> July, 2011.

On satisfactory progress/ completion of the earlier Projects, the Project: INDIGEO-3 was signed between GSI, Kolkata and ITC, Enchede, the Netherlands concerning 'Collaboration in

strengthening capabilities in the application of digital methods in geological, geophysical and geochemical mapping and geo-hazard assessment' for 5 years, which will end in 2012.

## 2. India-China

A MoU on scientific cooperation between GSI and China Geological Survey (CGS) in geosciences was signed on 14<sup>th</sup> January, 2008 and shall remain in force for a period of five years.

Areas of cooperation under the MoU include the following:

- (i) Palaeo climatic and Palaeo-environmental changes in Asian Continent through Speleological Studies with the aid of TIMS-U Dating and Stable Isotope Studies.
- (ii) Dating of Indian khondalites for provenance characterization and correlation with similar rocks in other parts of the world
- (iii) Technology exchange on sampling and laboratory methodologies used in geochemical mapping for mineral resource.

Dr. S.K. Wadhawan, Dy. Director General, SU; Rajasthan, WR, Jaipur participated as a member of the Indian delegation in the China Mining (Congress & Expo) 2011 held at Tianjin, China and also in field visits from 6<sup>th</sup> to 11<sup>th</sup> November 2011.

## 3. India-Argentina

MoU pertaining to scientific and technical cooperation in the earthsciences between Servicio Geologico Minero Argentino (SEGEMAR) of the Argentine Republic and GSI was signed on 14<sup>th</sup> October, 2009.

The scientific and technical cooperation in the field of Earth Science between the parties as identified in Article 2 are as follows:

- 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.
- The specific areas of cooperation on areas of mutual interest as mentioned in Article 3 are as follows:
  - Regional geology and mineral resources assessment
  - Geophysical exploration for mineral resources
  - Marine Geology
  - Other areas such as Subduction Tectonics
  - Geographical Information System (GIS)

## 4. GSI-USA Universities

The MoU on the collaborative study on "Rotation, Fragmentation and Flexure at the Northeast Corner of the Indian Plate" involving Geological Survey of India (GSI), the Regents of the University of Colorado, Michigan University and California State University, Northridge, USA was

signed on 27<sup>th</sup> January, 2009. The MoU will remain valid upto March 2014. As a follow-up action, Dr. Roger Bilham, Prof. of Geology, University of Colorado, USA visited the project areas in North Eastern India during 30<sup>th</sup> May to 5<sup>th</sup> June, 2009.

## 5. India-Bhutan

### GSI-WAPCOS Ltd.

The MoU between GSI and Water and Power Consultancy Services (India) Ltd. (WAPCOS) concerning preparation of Detailed Project Report (DPR) for Punatsangchhu Hydro Electric Power Project - II, Bhutan was signed on 01 February, 2008 on approval of Ministry of Mines.

Another MoU between GSI and Water and Power Consultancy Services (India) Ltd. (WAPCOS) concerning additional work around the modified Dam Axis site and its other components of Punatsangchhu Hydro Electric Power Project - I, Bhutan was signed 3<sup>rd</sup> September, 2008 on approval of Ministry of Mines.

## 6. India-Nepal

### GSI-JPO SKSKI

The MoU between GSI and Joint Project Office, Saptakosi Sunkosi Investigation (JPO-SKSKI), Nepal for carrying out geological investigations required for preparation of Detailed Project Report (DPR) for Saptakosi and Sunkosi Project, Nepal was signed in March 2007. Subsequently, the validity of the MoU was extended till March 2012.

## 7. India-Saudi Arab

The Agreement on 'Technical Cooperation Programme between Saudi Geological Survey and Geological Survey of India' has been signed on 2nd March, 2011 by Dr. K.Ayyasami, Deputy Director General, GSITI at Jeddah, Saudi Arabia. As a follow-up action of the agreement GSITI is giving training in various fields of earth science for the geoscientists of SGS covering all the aspects discussed during the visit.