

Geological Survey of India (GSI)

Introduction

The Geological Survey of India (GSI) was set up in 1851, initially with the objective of locating coal for the railways. GSI over the years has expanded its role to undertake investigation of the geological set up of the country, including assessment and regional level exploration for coal and other mineral resources.

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

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

Thrust Areas of Activity

The broad thrust areas for GSI are identified, keeping in view the planned objectives of the XI Plan and declared national priorities are:-

- Creation and updation of national geoscientific information and knowledge base through ground, marine, airborne and remote sensing surveys.
- Increased emphasis on concept oriented thematic geological mapping on progressively larger scales and geochemical and geophysical mapping on 1:50000 scale
- Mineral resources assessment through regional exploration.
- Shallow Subsurface Geology for locating coal and mineral deposits
- Geotechnical advice and guidance for dams, roads and rail transport and other civil engineering construction projects.
- Knowledge inputs in natural hazard studies and disaster management including earthquake and landslide zonation studies.

- Geo-environmental investigations for both regional and site-specific studies for societal needs.
- Computerised archival, analyses, retrieval of all geoscientific data and creation of theme-based relational database.
- Dissemination of data through maps, publications and through internet GSI portal etc.
- Training in specialised fields of geology, geophysics and chemistry for upgradation of technology and expertise.
- Modernisation and upgradation of laboratories and field oriented geosurvey facilities.

Modernization in GSI

The Geological Survey of India has undertaken an extensive programme of modernization during the XI Plan period. The modernization programme is aimed at refurbishing and upgrading the in-house capabilities of GSI. Under the Modernization programme, GSI proposes to acquire a new Ocean-going research vessel as a replacement for the aging RV Samudra Manthan, a new Geotechnical Vessel with shallow drilling capacity, a Heliborne Geophysical Survey System and a replacement of its fixed-wing aircraft. The Government has approved the proposal for procurement of the new research vessel at an estimated cost of Rs. 448 crores. The procurement action has started with Shipping Corporation of India (SCI) identified as the Indian Consultant. The Government has also accorded approval for the acquisition of a Geotechnical Vessel at a cost of Rs. 72 crores. Proposal for appointment of SCI as the Indian Consultant has been initiated. Procurement action for Heliborne Survey System of 4 sensors (gravity, magnetic, time domain electromagnetic and radiometric) along with a hyperspectral camera to be fitted to the helicopter is underway. The Feasibility Report for acquisition of a new Fixed Wing Aircraft and geophysical sensors (gravity, magnetic, electromagnetic and hyper spectral) are to be finalized by GSI shortly. In addition, Inductively Coupled Plasma Mass Spectrometer (ICPMS) equipment for chemical analysis, Electron Probe Micro Analyzer (EPMA) to study of mineral phases in rocks and Scanning Electron Microscope (SEM) to study naturally occurring specimens up to a magnification of about 1 lakh times, are planned for many laboratories.

Organization Set-up

The GSI with the Director General as its head, functions as a subordinate office of the Ministry of Mines. The Director General has the overall responsibility of planning, programming, financial and material management, monitoring of scientific activities, dissemination of information and advice to Government on geoscience related issues. For operational purposes, GSI is divided into six Regions (geographically based), three specialized Wings (activity based) and Training Institute that is controlled from the Central Headquarters in Kolkata. The Senior Deputy Directors General/Deputy Directors General (HAG/SAG level) head these Regions/Wings and function as "Head of Department" (HOD) to oversee the formulation and implementation of annual programmes, exercise budgetary

control, allocate the resources, determine the relative priorities, and effect executive and other controls on Divisions/Projects within the Regions/Wings.

Besides having functional Units in the respective headquarters, each of the Regions comprises State based Operational Units, which are mostly headed by SAG level officers. The specialized Wings also comprise sector-wise functional Units, in addition to the headquarter set-up. The Training Institute, located at Hyderabad, has satellite training centers at 6 locations in different parts of the country. An SAG level officer (Deputy Director General) co-ordinates the activities related to the programme formulation, administration and technical control and provides infrastructure support for implementation besides operating the allocated budget, and coordinates the inter-disciplinary activities. The structure of the organizations is given in Figure 8.1.

The primary functions of collecting the basic geological information is carried out by GSI through its Divisions/Projects spread all over the country. Clusters of such Divisions and Projects, normally headed by JAG level officers, are located at the Regional and Operational offices and in many outlying stations, totalling 33 cities/towns in the country.

The support activities to the geological investigations are provided by independent set-ups in the complementary disciplines like geophysics, chemistry, drilling, mechanical engineering, materials management, finance and administration. Each of these establishments is based at Regional or Operational offices and is headed by an officer of the level of Dy. Director General/Directors/ Time Scale officers.

Programme Formulation in GSI

The Government set up the Central Geological Programming Board (CGPB) by Government Resolution in 1966 for formulation and implementation of the programmes in the earthscience area, with close co-ordination between GSI and State Geological Departments and other central agencies. CGPB is supported by State level Programming Boards and various Subcommittees formed for the development of various mineral and geoscience based issues. While finalizing the programmes of GSI, the Government policies and directives, suggestions and recommendations of Five-Year Plan document, Sub-committees of the Central Geological Programming Board and State Geological Programming Boards are considered.

After final scrutiny at Central Hqrs., GSI's annual programme documents, mostly State-wise and activity-wise, are placed before the Central Geological Programming Board (CGPB) for approval. The 43rd Meeting of the CGPB was held on 29th September 2008 which approved the Annual Programme for the field season year 2008-09 (October 08 – September 09). The 44th Meeting was held in February, 2009 to review progress and examine policy and strategy issues.

High Powered Committee

The Cabinet, in its meeting held on 1.10.2007, directed that a High Powered Committee (HPC) be set up to thoroughly review the functioning of GSI and assess its capacity to meet the emerging challenges taking into account the organisation's technological and manpower resources. Accordingly, a High Powered Committee was constituted under the chairmanship of Additional Secretary (Mines), vide the Ministry of Mines' order dated 7.1.2008. Representatives of the Planning Commission, the Department of Science and Technology and GSI, and management experts are members of the HPC. The Committee held 13 meetings, and reviewed the existing work, obtained GSI's own vision and also interacted with the U.S. Geological Survey and the National Resources, Canada to understand global trends, identify new and emerging technologies & methodology of survey, mapping, data management, overall management etc. Needs of the stake-holders were assessed keeping in view of national priorities.

The Committee submitted its report to the Government on 31.3.2009. Some of the important recommendations are given in the Annexure 8.1.

Central Geological Programming Board

The Central Geological Programming Board (CGPB) was established through Government of India Resolution dated 27th July, 1966. The CGPB was constituted primarily to co-ordinate activities on geological mapping and mineral prospecting, exploration and exploitation in the country, with the Geological Survey of India (GSI) as the nodal department and the State Geology and Mining departments and Central Government institutions as the participating members. Subsequently, to complement the activities of the CGPB, State Geological Programming Boards (SGPB) were constituted in the States to co-ordinate geoscience activities within the State and to interface with the CGPB and GSI. Accordingly on 12th March, 2009, the CGPB has been reconstituted under the Chairmanship of Secretary, Mines, Government of India, with more broadbased representation from Central Ministries and Institutions, State Governments and Private Industry.

The Central Geological Programming Board shall meet at least once in six months, and shall be responsible to:-

- (i) help provide the general strategic direction of geoscience activity in relation to GSI and other stakeholders, and advise the Ministry of Mines on policy issues of geoscience.
- (ii) effect programmatic coordination among central agencies in the sector and promote multi-disciplinary / multi-institutional approaches.
- (iii) enable better interaction between central agencies and State level organizations for coordinated planning and execution.

- (iv) help build training, Human Resource, and research capability within the sector particularly at State level and coordinate the capability for optimum use.
- (v) identify new areas and new technologies for geoscientific activities, and advise on adoption strategies.
- (vi) advise on Geoscience partnerships between GSI, and State and Central Level or other agencies including research and academic institutions.
- (vii) actively promoting use of Information Technology in geoscientific activity, develop Geoinformatics with a strong spatial database; facilitate coordination among geoscientific agencies to develop common standards and sharable databases under the National Spatial Data Infrastructure (NSDI) architecture; and encourage wide and easy dissemination of geoscientific information through internet based technologies.
- (viii) approve five-yearly detailed sub-sectoral targets on a rolling plan basis and annual programme on a State-wise basis.

The Central Board shall be supported by 12 Committees for the various sub-sectors as follows:-

- Ferrous Minerals (Iron, Manganese & Chromite, etc.)
- Precious Metals & Minerals (Gold, Platinum Group of Elements, Diamond & Precious Stones)
- Non-Ferrous and Strategic Minerals (Basemetal, Tin, Tungsten, Bauxite, etc.)
- Industrial & Fertilizer Minerals
- Energy Minerals & Resources (Coal, Lignite & Geothermal)
- Marine Geology & Exploration and Coastal Geoscience
- Airborne Survey & Remote Sensing
- Geology & Mineral Resources of North Eastern Region
- Geoscientific Investigations (Geotechnical investigation, natural hazards, climate change, Environmental Geology, Shallow subsurface Geology & Subsurface Hydrology)
- Fundamental and Multidisciplinary Geoscience
- Geoinformatics and data management
- Geoscience for Sustainable Development.

There shall be a dedicated full-time secretariat for the Central Geological Programming Board and for each of the Committees, which shall be serviced by the GSI. GSI shall bear the expenses on account of TA/DA as per Government of India notification and entitlement, for one member of each State Government for attending the Committee meetings.

To facilitate coordinated planning, taking into account State-Level priorities for survey, mapping, exploration and other geoscientific activities, and also to help factor in State-Level requirements for training, HR and technical capacity building into the programmatic framework, each State Government would be encouraged to constitute a State Level Geological Programming Board and to activate the Board where it already exists. Guidelines will be issued by the Ministry of Mines in consultation with GSI, and as per the recommendation of the Central Board to facilitate constitution/ reconstitution of such Boards to better serve the geoscientific interests of the State Government. The State Level Boards may include local representatives of GSI and other Central and State-Level stakeholders and private agencies having an interest in the State-Level geoscientific programme and may be mandated with activities at State-Level similar in nature and scope as the Central Board, so as to enable the Recommendations of the State Boards to form a primary input for the Central Board and its Committees.

The Ministry of Mines and GSI place high importance to building partnerships with State Government institutions and help build up capacity through the mechanism of the State Boards and otherwise. Accordingly, 10% of GSI's Plan budget for its Schemes will henceforth be earmarked for activities recommended by State Level Boards and fitting in with the overall framework of the Five Year Plan. Preference will be given to such activities where there are any or all of the following:-

- (a) Active participation of State Government in survey, exploration or research
- (b) Sharing of State Government data, particularly long-term collaboration on sharing of spatial databases.
- (c) Use of State Government infrastructure and facilities including laboratories.

Performance of GSI during 2008-09

Geoscientific Baseline Data

Geological Mapping

Systematic Geological Mapping

The fundamental activity of GSI is the systematic geological mapping on 1:50,000 scale of the country. Out of the total mappable areas of 3.146 million sq.km. of the country, 3.09248 million sq.km. (98.305%) has already been completed. An area of 280 sq. km. has been covered by systematic mapping up to March 2009 during 2008-09.

Specialised Thematic Mapping (STM)

GSI has launched specialized theme oriented large-scale (1:25,000 or larger) studies/mapping items from the VIII Plan period to resolve complex geological continuum and structures. A total of 133899.5 sq. km. has been completed and during the current Plan period, coverage of 6399 sq.km. has been achieved (up to March 2009).

Geochemical Mapping (GCM)

Geochemical mapping is a worldwide technique not only for finding /managing/developing natural resources but also for application in environmental studies, public health and other societal issues. GSI has initiated a national geochemical mapping programme during 2001-02. During the X Plan period 1, 13,174 sq km and in XI Plan 33,143 sq km (up to March, 2009) has been covered. With the available laboratory techniques 68 elements are analysed up to the 'Clarke' level. The thrust on "Geochemical Mapping" shall be continuing in almost all the States especially in the mineral potential areas. The analytical results plotted as elemental contour diagrams on available geological and geophysical base maps/data sets are statistically analysed, under GIS platform.

Geophysical Mapping (GPM)

Systematic ground gravity-magnetic mapping for preparation of G-M maps of the country (on 1: 50,000 scale) has been initiated during the X Plan Period. The mapping process involves acquisition of gravity-magnetic data at a number of stations with an average density of one station per 2.5 sq km area. This will also help in revealing the sub surface geology as well as demarcating the probable hazard areas from environmental point of view. Systematic gravity and magnetic (VF) mapping covering 70,183.30 sq. km. area during X Plan period and 44,646.50 sq km during current Plan period (up to March,2009) have been completed.

Aerogeophysical Survey

The Airborne Mineral Surveys and Exploration Wing (AMSE) of Geological Survey of India presently carry out airborne surveys to obtain aerogeophysical data by deploying Magnetic and Gamma Ray Spectrometric (GRS) Sensors. Subsequently, the aerogeophysical data is processed and interpreted to identify the aerogeophysical anomalies for the preparation of aerogeophysical maps. Ground follow up and evaluation by geological, geochemical and ground geophysical surveys and finally, exploration by drilling of potential target areas are done in anomalous zones. Surveys are carried out by the Twin Otter Airborne Survey System (TOASS) with Magnetic and Gamma Ray Spectrometric sensors acquired by GSI in 1986. Up to field season 2007-08, 4, 52,061 line km over an area of 2, 43,015 sq km was covered. During the Field Season 2007-08, the aerogeophysical survey data was acquired using the multi-sensors over 19,628 line km covering an area of 33,443 sq km in the following areas: i) Western offshore area between Kanyakumari and south of Kannur (Tamil Nadu and Kerala) and ii) Kanker-Dhamtari area in Bastar Craton, Central India, Chhattisgarh.

During FS 2007-08, processing of aerogeophysical data involving 32,500 line km has been completed and final contour maps have been prepared. Processing of multisensor aerogeophysical data of Baihar – Kutru area in parts of Madhya Pradesh, Chhattisgarh and Maharashtra flown during the F.S. 2006 – 07, was under progress. Geophysical modeling at the junction of the Western and Eastern Dharwar Craton, Deccan Trap covered Gondwana

Basin in Nagpur-Wardha areas of Maharashtra to delineate Gondwana basin under Deccan Trap, west of Wardha valley. Arc GIS work pertaining to topography and geology theme is complete and incorporation of airborne survey data is in progress.

Marine Survey

Geological Survey of India carried out off shore geo-scientific studies both in Exclusive Economic Zone (EEZ) and Territorial Water (TW) along the East and West coasts of India. Surveys in the near shore zones (00m-10m isobaths) were carried out using hired small mechanical boats. The Marine Survey is to assess the seabed minerals, seabed morphology and sedimentary processes.

Geological Survey of India has completed seabed mapping of 1,23,941 sq km within Territorial Water and 18,48,318 sq km in the EEZ beyond Territorial Waters till FS 2007-08. No cruise could be undertaken onboard RV Samudra Manthan due to major overhauling of the ship.

Eight cruises were launched in the Territorial Waters by the coastal research vessel R.V. Samudra Kaustubh for conducting seabed surveys off Ganga and Mahanadi deltas and offshore Tamil Nadu, placer mineral resource evaluation in the territorial waters off Isakalapalem, AP, and geotechnical appraisal of inner shelf off Dibbalapalem to Santapalle, A. P.

Seven cruises aboard the coastal research vessel R.V. Samudra Saudikama within the territorial water off the west coast were undertaken for mapping of the sea bed within the gulf of Kachchh off Mandvi, Gujarat, geotechnical appraisal off Murud-Janjira, Maharashtra and off Chellanum, Kerala, investigation for construction sand within territorial waters off Ponnani & Chavakkad, Kerala coast, parametric studies within territorial waters off Kerala coast between Ambalapuzha and Anjengo (Ambalapuzha- Karunagapalli sector).

Mineral Resource Assessments

Though mineral prospecting and exploration is open to the private sector in the backdrop of liberalized economic scenario of the country, GSI is regarded as the prime source for basic earth science data up to the level of preliminary exploration. With the near exhaustion of resources in the proximity of the surface it has become imperative to adopt a multidisciplinary approach to mineral exploration. The resource evaluation in GSI is done in conformity with the exploration input for G4, G3 and G2 (partly) stages of the UNFC system. Present day mineral search and assessment is being undertaken with special emphasis on deficient commodities of high value (e.g. gold, diamond, PGE etc.), strategic minerals (molybdenum, tungsten) as well as ores and minerals of high demand (basemetal, iron ore-haematite and magnetite, coal, lignite, limestone for steel industry etc.).

During the annual programme 2008-2009, 85 items are planned for mineral investigation of which 20 items are under coal/lignite, and 65 items belong to ore and mineral (including

ground follow up of air borne anomalies). Of the 65 items, 17 items for gold, 11 for diamond, 20 of base metal, 3 of PGE and 6 of ferrous minerals are taken up.

Physical inputs for implementation of above programmes were 110.80 sq. km for large-scale mapping, 20.305 sq. km of detailed mapping and 63078 metres drilling (up to March, 2009)(Annexure 8.2). Laboratory supports in the form of chemical, petrological and mineralogical determinations were also given.

Coal & Lignite

The exploration for coal has been carried out in different Gondwana basins of Andhra Pradesh (1 items), Chhattisgarh (5 items), Jharkhand (5 items), Madhya Pradesh (5 items), Orissa (5 items) and West Bengal (4 items) totaling 25 items in all, including 6 promotional items. There were three exploration items for lignite, two in Rajasthan and one in Tamil Nadu out of which two items are promotional.

Regional exploration for coal and lignite under the ambit of promotional drilling (8 items) sponsored by the Ministry of Coal was carried out in FS 2007-2008.

The geological resources of coal of the country stand at 264.53 billion tonnes and the inventory of the lignite resource of the country based on data supplied by different agencies viz., NLC, MECL and DMG, Rajasthan, a total of 38.93 billion tonnes of lignite has been estimated as on 01.04.2008. An additional resource of 2760 million tonnes of coal has been assessed from the data generated from regional exploration by GSI during FS 2007-2008 (up to June, 08). Coal Wing, GSI has formulated a total of 20 exploration items for FS 2008-2009, out of which 17 items fall in CIL, 1 item in SCCL and 2 items in lignite bearing areas.

Coal Bed Methane

CBM study for in-situ gas content in Gosainpahari-Siulibana block of Rajmahal-Birbhum Master basin gave highly under saturated in methane value (0.03 cc/gm to 0.28 cc/gm) in most of the samples.

Resource Augmentation (non-coal sector)

Gold

Exploration for gold in Ajjanahalli Block - B, Tumkur district revealed six mineralized zones forming two groups with a gap of 60 to 75m. Two promising zones with persistent gold values ranging from 0.43g/t X 1.92m to 1.82g/t X 4.21m true width are identified.

During the FS 2007-08, a resource of 5.36 million tonnes gold ore was estimated in Delwara West block, Rajasthan with 2.09g/t gold. The total gold ore resource in Bhukia Gold Belt, Banswara District, Rajasthan, has been augmented from 55.22 million tonnes with 1.87g/t Au to 60.58 million tonnes with 1.89g/t Au.

In Sonakhan area, Raipur district, Chhattisgarh, a resource of 0.09 million tonne of gold mineralisation was estimated with average grade of 0.93 g/t of gold.

Diamond

Two new kimberlite bodies (CGK-3 and 4) in Chagapuram sub block, Mahaboobnagar district, Andhra Pradesh were discovered in addition to the pipes CGK -1 and CGK -2 discovered last year. Three boreholes were drilled to test the depth extension and to collect samples.

Platinoid Group of Elements (PGE)

PGE mineralisation in Hanumalapura block-A, Davangere district, Karnataka showed a strike length of 1.8 km mineralized zone of which 1.0 km zone had indicated a resource of 0.84 million tonnes of PGE ore. In the adjacent Hanumalapura Block – B and C, surface continuation of the mineralization has been established. Investigation in both the blocks was abandoned due to adverse ground condition.

Moderate PGE values (0.24ppm Platinum and 0.52ppm Palladium) for 225 m over a width of 6.0m has been delineated in Mettupalaiyam Ultramafic Complex, Coimbatore and Erode districts, Tamil Nadu.

In Sittampundi Layered Ultramafic Complex, Namakkal district, Tamil Nadu a prominent mineralized zone has been traced for about 900m strike length with an average grade/width of this zone being 1.68ppm (Pt+Pd) / 1.55m in the eastern part, 1.11ppm (Pt+Pd) / 2.20m in the central part and 0.70ppm (Pt+Pd) / 1.20m in the western part.

Basemetal

Resource for basemetals has been augmented in the State of Rajasthan. In Baniwala-ki-Dhani, Sikar District, copper resources was augmented by 2.01 million tonnes to 20.18 million tonnes with an overall grade of 0.47% Cu. In Kundla-ki-Dhani block the ore resources were recalculated to 2.71 million tonnes with an overall grade of 0.37% Cu; augmenting the resources by 0.78 million tonnes. After recalculation the resource in Dokan block stands at 42.41 million tonnes with an overall grade of 0.40% Cu with an augmentation of 16.85 million tonnes ore resources in this block. In Dokan North block the recalculated resource is 19.96 million tonnes with an overall grade of 0.37% Cu with an augmentation of 14.36 million tonnes ore in the block.

Investigations for base metals are being carried out in the states of Maharashtra, Madhya Pradesh, Haryana, Himachal Pradesh and Meghalaya.

Iron Ore

A resource of 6.20 million tonnes of iron ore with 55% to 60.6% Fe has been estimated in Ghoraburhani block, Sundergarh district, Orissa. In Pathuripenth-Madhyapur area, Kendujhar district, a resource of 0.043 million tonnes of iron ore has been estimated.

Investigation for iron ore resources in selected free hold areas in NMDC block in parts of Sandur Schist belt, Bellary district, Karnataka was continued during F.S. 2007-08. A part of the resource estimated during the last year has been upgraded from G-4 to G-3 of UNFC system based on exploration activity. Along with 55% cut-off, resource has been calculated at 45% and 50% Fe cut – off level also to know the grade- tonnage variation at different cut – off grade.

Iron ore investigations are also continuing in the states of Chhattisgarh, Tamil Nadu and Rajasthan.

Manganese

Exploration for manganese in Bolani block, Bonai-Kendujhar belt, Kendujhar district, Orissa has yielded a resource of 0.65 million tonne of Mn ore at 20% Mn cut – off. In Lasarda North Extension (Bolani) block, an additional resource of 1.365 million tonnes of Mn ore with an average grade of 26.42% Mn has been estimated at 20% cut off. In addition, 0.39 million tonnes of marginal grade (15-20 % Mn) manganese ore has been estimated in this block.

Limestone

Investigation for flux grade limestone in Niwar area, Katni district, Madhya Pradesh has augmented a resource of 1.49 million tonnes with an average grade of 48% CaO.

Special Studies

Geotechnical Investigations

Forty two items of geotechnical and engineering geological studies through 319 investigations were undertaken related to civil engineering projects for water resource development, communication and miscellaneous projects in almost all the States of the country as well as in neighboring countries. Some of the important projects taken up are as below:

- Tehri, Koteshewar Hydroelectric projects, Uttarakhand.
- Ranjit Sagar Dam Project, Punjab
- Koshallia Dam Project, Haryana
- Luhri HE Project, District Shimla, Himachal Pradesh
- Katra-Qazigund Rail line section, District Reasi, Jammu and Kashmir
- Vagada Minor Irrigation Tank Project, District Sindhudurg, Maharashtra
- Sanjay Sagar Project, District Vidisha, Madhya Pradesh
- Sikasar Project, District Raipur, Chattisgarh
- Billiya Reservoir Scheme, Pokaran, Rajasthan

- Gorakallu balancing reservoir SRBC District Kurnool, Andhra Pradesh
- Mambazhathuraiyar Reservoir Project, District Kanyakumari, Tamil Nadu
- Thottiyar HE Project, Kerala
- Garhi Reservoir Scheme, District Chhatra, Jharkhand
- Kalejkhola HE Project, West District, Sikkim,
- Hadua Irrigation Project, District Cuttack. Orissa
- Rammam Hydel Project, Stage-II, District Darjeeling, West Bengal,
- Chidyatapu Water Supply Scheme, South Andaman
- Kameng H.E. Project, Arunachal Pradesh
- Punatsangchu Hydroelectric Project - I & II, Bhutan

The detailed geotechnical investigation for the conservation of the archaeological monuments at Ajanta & Ellora Caves District Aurangabad, Maharashtra, has been carried out. Geotechnical mapping of 3670 sq.m of inaccessible scarp housing Ajanta caves and 5950 sq.m in Ellora caves have been completed. The tell-tale monitoring data of Ajanta suggests movement in 15 caves along 28 cracks.

Landslide Hazard Studies

The National Core Group under the directives of Ministry of Home Affairs formulated an Action Plan in the year 2004 on Landslide Hazard Risk Mitigation in consultation with GSI and other Government and Non Government Agencies and entrusted GSI for its implementation and distribution of envisaged workload to other agencies.

About 2425 sq. km. area covering about 615 line km road corridors have so far been completed by Landslide Hazard Zonation (LHZ) on Macro scale during F.S. 2007-08.

LHZ studies on Meso-scale (1: 10,000) were carried out in Joshimath, Chamoli District, Uttarakhand, Munnar area, Idukki District, Kerala, and Madikere Town, Coorg District, Karnataka.

Preparation of Landslide Inventory, site specific study and / or monitoring of landslide in different parts of the country is being continued. Real time monitoring through instrumentation in Survee landslide, Mussoorie, Uttarakhand and Hospital landslide, Coonoor District, Tamil Nadu is being undertaken in collaboration with Geological Survey, Canada to develop early warning system in order to minimize loss of life and property.

GSI has taken up two scientific research projects one each in Darjeeling district, West Bengal and in Nilgiri Hills, Tamil Nadu in association with ITC, Netherlands.

The Disaster Management Support (DMS) Control Room installed in the GSI's New Delhi Office is operational. The data on landslide incidences is being transferred to the Disaster Management Support Network of Ministry of Home Affairs.

Earthquake Geology

GSI has long been engaged in seismic hazard assessment of earthquake prone areas by studying the possible source regions of earthquake (termed "active fault studies") as well as study of the sites where the tremor is likely to cause considerable damage due to geological conditions (known as "seismic hazard microzonation"). In the study of active fault mapping, nature and characteristics of the seismogenic fault and its recurrence interval provide significant insights on the causative source. Active fault studies involving multifarious inputs of geological, geophysical, seismological, geodetic techniques, have been carried out in the Ropar Tear of Haryana and Punjab, Spiti Valley and Kaurik fault in Himachal Pradesh, Tapi North Fault in Maharashtra and Madhya Pradesh, Nagrakata-Rajabhatkhawa sector in the Himalayan foothills of West Bengal and in the Bhutan foothills at Kokrajhar, Assam along with ground deformation study by DGPS in Dibang Valley of Arunachal Pradesh, in Andaman Islands and across Great Bengal Fault, Darjeeling and North Dinajpur Districts, West Bengal.

Broad Band Seismic (BBS) observatories at Nagpur and Jabalpur are operated by GSI to record earthquake events of the distant, regional and local origin. Seismic recording was also done at Sirsod, Khandwa district and Balapat, Burhanpur district of Madhya Pradesh. The permanent geodetic GPS installed at Jabalpur observatory and in Lucknow were kept operational and data was supplied regularly to National GPS Data Centre, Survey of India, Dehradun for further processing/interpretation. To work out seismogenesis of Darjeeling-Sikkim Himalaya, temporary seismograph network were deployed to monitor the seismicity.

Geoenvironmental Studies

Twenty one geoenvironmental investigations were taken up during F.S. 2007-08. These include Regional Geo-environmental Appraisal, Site/Theme Specific Geo-environmental Studies, Public Health Hazards, Desert Geology, and Studies on Coastal Dynamics & Fluvio-Geomorphic Dynamics. One item of Syn-Exploration Baseline Data Generation was also taken up.

Arsenic pollution in ground water has been a major problem in the Gangetic plains of U.P., Bihar and West Bengal. GSI has been working relentlessly to provide maps depicting arsenic free groundwater areas to the affected people. Studies on Arsenic pollution of ground water were also carried out in Imphal valley in Manipur, in collaboration with DGM, Manipur.

Glaciological Studies

Detailed glaciological studies on Hamtah glacier, Lahaul-Spiti District, H.P, were carried out for the eighth consecutive year.

Study of recessional pattern of glaciers of Bhaga basin, Lahaul - Spiti district, H.P. was undertaken for Panchi Nala I and Panchi Nala II glaciers.

Antarctic & Arctic Studies

GSI has been participating in expeditions to Antarctica since 1981. The GSI team carried out thorough field studies on the shear zones of Schirmacher Oasis and about 200 oriented samples have been brought for further studies in the laboratory to gain deeper insight in the tectonic and metamorphic history of the region. Routine glaciological observations were carried out revealing an accumulation of 65.5 cm snow during 2007-08 on the ice shelf along Princess Astrid Coast. Overall average recession of Dakshin Gangotri glacier snout in Schirmacher Oasis during the same period was recorded to be 1.10m.

Two members from GSI participated in the 1st Indian Arctic Expedition held in March 2008.

Geoinformations

GSI net – Portal Project

GSI Enterprise portal (<http://www.portal.gsi.gov.in>) (Beta version) has been live since 5th November, 2007. The Information Infrastructure is expected to be fully functional by the end of 2008 once the Wide Area Network (WAN) is commissioned fully. The information infrastructure once fully implemented will facilitate knowledge creation, paper less administration, comprehensive information management, dissemination of information amongst various stakeholders, revenue generation and e-governance and enhance the visibility of the organization and furthermore, provide a cost-effective means for its sustenance and growth.

Creation of Local Area Network (LAN) at different offices of GSI and connecting these isolated LANs over Wide Area Network (WAN) through MPLS IP VPN connectivity will act as the backbone for all applications pertaining to GSI Portal, IP telephony, video-conferencing and corporate Internet connection. During 2008-09 commissioning of WAN, installation of applications and connectivity at the Disaster Recovery Centre (DRC) to ensure continuity of operations in the event of failure of the primary site will be achieved.

The portal meta- database is continuously being populated with information on published maps, unpublished progress reports (> 22,000), and different publications of GSI. A new section on State Geology and Mineral maps published along with Misc. Pub 30 has been incorporated. Map service on geology of India at 1: 5 million has been upgraded to 1: 2 million with more information. Map services pertaining to Coal and Marine Geology have also been updated.

Maps, Publication and Databases

5,065 toposheets cover Indian Territory, of which 4440 discrete maps were compiled scrutinized and digitized.

- Out 334 quadrangle maps (scale 1:2, 50,000) suitable for printing, 289 maps have already been printed till June 2008. 12 maps are proposed for printing during F.S.2008-09.

- ❑ During FS 2007-08, compilation of seamless geological map of South Asia on 1: 5M scale has been completed for both lithostratigraphic and structural layers. During FS 2008-09, it is proposed to create database for polygon, arc and point features, through "Data input programme" as supplied by Commission for the Geological Map of the World.
- ❑ Soft Copy Conversion of Geological Maps of Archival Interest and Published Maps of GSI were continued and about 8000 maps of archival interest (from year 1840 – 1930) and some old sketches and maps (from year 1840 – 1860) were converted into softcopy. During FS 2007-08, soft copy conversion and metadata base generation for 370 maps have already been done.
- ❑ GSI, Marine Wing, took up compilation of the seabed maps covering the entire EEZ of India in 2° X 2° sheets. Accordingly, 63 EEZ maps and 149 territorial water maps are to be compiled. 22 sheets of EEZ maps, one sheet of Territorial water map, and a special category map have been printed till the current FS.
- ❑ During F.S. 2007–08, a total of 23 publications including five newsletters from different regions have been released by GSI till July, 2008.
- ❑ During 2008-09 the main thrust will be migration of legacy data (especially, the 1:50,000 map databases generated through Geoinformatics and 1:50K map compilation and digitisation, Coal block maps and seabed survey maps) and incorporation of new data into the Enterprise GIS system. The Marine Geosciences database too is being enriched through population of data pertaining to 100 cruises (both EEZ and territorial waters).
- ❑ Creation of theme-based geoscientific database continued in distributed centres and forty-seven degree sheets are in various stages of completion. Data automation has been done in 1:50K, drilling, Mining Exploration, Geochemical, Geophysical, PGRS and Environment domains. All data generated through Geoinformatics project will be migrated to the Enterprise GIS system.

Support Services

Human Resource Development & Training

Since its inception in 1976, the Geological Survey of India Training Institute (GSI TI) has conducted over 700 training programmes (up to September 2008) and trained 12,089 geoscientists of GSI, other earth science organizations and universities of the country and also geoscientists from ESCAP and SAARC countries. The training programmes are focused on fundamentals and applied aspects of geosciences viz. Geology, Geophysics, Geochemistry, Natural Hazards, Remote Sensing, Drilling and Surveying. The Institute regularly conducts DST (Department of Science & Technology) supported programmes, ISRO (Department of Space) supported Remote Sensing (NNRMS) programmes, customized courses for other agencies and administrative courses for the departmental

personnel. For strengthening the application of digital techniques in Geoscientific data processing, a collaborative venture named Project INDIGEO between the Geological Survey of India, International Institute for Geo-information and Earth Observation (ITC) and Maastricht School of Management (MSM), the Netherlands and Association of Exploration Geophysicists (AEG), India was launched in 1999 and is being continued with ITC without financial commitments by the Government of India.

During the Field Season 2007-08, 31 Training courses were taken-up in GSI Training Institute. It included one orientation course, 13 scientific courses, 7 technical courses, 7 administrative courses and 4 sponsored courses.

Geoscience Partnerships

MoUs with Central Organisations

MoUs have been concluded/being concluded with several PSUs and Government agencies by GSI. Important among these are:

- (i) MoU between GSI, WR and Jaipur Development Authority on environmental Geological assessment on Jaipur Region concluded at Rs.4, 94,164/-.
- (ii) MoU between GSI, NER & SEW Construction Ltd. for Geological investigation for NAFRA Hydro Electric Project, Arunachal Pradesh concluded at Rs. 3,76,671/-.
- (iii) MoU between GSI, NER & SEW Construction Ltd. for Geotechnical investigation for NAFRA Hydro i) Electric Project, Arunachal Pradesh approved at Rs. 6,47,749/-.
- (iv) Modified MoU between GSI and WAPCOS Ltd on Punatsangchhu Hydro Electric Power Project-I, Bhutan at the cost proposal (Rs.23, 57,546/-) in respect of work concerning additional work around the Dam axis site and its other components is being finalised.
- (v) A draft of MoU for Rs.71, 80,378/- on Techno Scientific Survey of Nayachar Island and its environs, East Midnapore District, West Bengal has been submitted to Government of West Bengal for approval.
- (vi) The Cost proposal of the sponsored Geotechnical work for All India Radio, Kohima, Nagaland has been approved (Rs.2, 21,269/-).
- (vii) As per the MoU with ASI, geotechnical studies were continued at Ajanta & Ellora.
- (viii) GSI, Central Region signed MoU with NTPC and MOIL during F.S.2007-08. MOIL paid Rs. 12,00,606/- as an advance payment for Geophysical Survey to be done in North Tirodi area.

International MoUs

The following bilateral agreements are in operation (Table No. 8.2).

In addition GSI participate in large number of international programmes, symposia and workshops as given in Table No. 8.3.

Apart from above programmes Geological Survey of India participates regularly in PDAC – International Convention, Trade Show, and investors exchange, Canada: World Mining Conference and is participating in the International Project – ONE GEOLOGY.

Bilateral Agreements of GSI with other Countries in operation

S.No.	Country	Date of MoU	Subjects
1	Canada	April 2004	<ul style="list-style-type: none"> • Development of a Mitigation Strategy to Manage Risk from Arsenic Toxicity in Groundwater of West Bengal, India. • Landslide Mitigation Project.
2.	Netherlands	July, 2007	<ul style="list-style-type: none"> • Project INDIGEO - 3 concerning "Collaboration in strengthening capabilities in the application of digital methods in Geological, geophysical, geo-chemical mapping and geo-hazard assessment". The MoU is for 5 years. • The MoU was signed among GSI, NRSA and ITC for the Ph.D Programme (partly in India and partly in the Netherlands) for 3½ to 4 years on 'Use of New Earth Observation Techniques for Landslide Hazard and Risk Assessment' in Himalaya and Nilgiri areas.
3.	Australia	May, 2005	<ul style="list-style-type: none"> • Cooperative Staff Development Related to Environmental Governance and Mine Rehabilitation'
4.	China	January, 2008	<ul style="list-style-type: none"> • Dating of Indian Khondalites for Provenance Characterization and Correlation with similar rocks in other parts of the world. • Palaeo-climatic and Palaeo-environmental changes in Asian Continent through speleological studies with the aid of TIMS-U Dating and stable Isotope studies.

- Technology exchange on sampling and laboratory methodologies used in geochemical mapping for mineral resources.
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| 5. | Nepal | – | <ul style="list-style-type: none"> • A MOU has been finalized for providing consultancy services to carryout geological/ geotechnical investigations for the Sapta Kosi and Sun Kosi projects, Nepal. |
| 6. | Bhutan | February, 2008 | <ul style="list-style-type: none"> • The MoU between GSI and Water and Power Consultancies Services (India) Ltd. (WAPCOS) concerning preparation of detailed project report for Punatsangchhu Hydro Electric Power Project - II, Bhutan was signed on 1st February 2008 and work is continuing. |

- **GSI – CWC:** GSI nominated an expert member for the Design Expert Team for the Dam Safety Inspection of Chhukha Dam, Bhutan on the request of Central Water Commission (CWC), Bhutan Investigation Division, Phuentsholing, Bhutan.

GSI's participation in International symposia and workshops

S. No.	Programme	Nature of GSI's participation
1.	International Geological Correlation Programme (IGCP)	GSI is the accredited nodal agency for IGCP activity in India and there are 11 are ongoing projects. Geological, geochemical and geophysical aspects, tectonism, metallogeny, environment etc., are the topics taken up for global analysis.
2.	Commission for the Geological Map of the World	GSI has been identified as Coordinator of South Asian part of the project for the compilation of the international geological map of Asia on a scale of 1:1.5 million.