



ICOGS ASIA-PACIFIC NEWSLETTER

No.2, October 1999

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From ICOGS Secretary for Asia and the Pacific

One year has passed since we published the first issue of the ICOGS Asia-Pacific Newsletter. It is our great pleasure to send you its second issue again.

We have received contributions to the second issue from seven organizations. The Geological Survey of Iran sent us the latest brochure, which introduce their organization. The Indonesian Geological Research and Development Centre also sent us their organization's recent brochure as well as leaflets to introduce their three recent projects. Original articles were submitted by the Department of Geology and Mines, Lao PDR and the Department of Mines and Geology, Nepal. An article titled "Capabilities and Services Available" was sent from the Geological Survey of India, while a copy of "National Mineral Policy", which Sri Lankan government has just announced, was sent from its Geological Survey and Mines Bureau. The Institute of Geological & Nuclear Sciences sent us an introductory article as well as the latest edition of their colourful A3-size newsletter, *Globe*, from which we included articles on their marine activities in this issue of the ICOGS Asia-Pacific Newsletter.

We would like to express here our sincere thanks to the contributors of the above articles. Inclusion of all the above articles made this issue total of 64 pages. We also tried to include colour pages for figures. There maybe a wide varieties of the situations among the seven organizations. You may find in the cited articles similarlities to your organizations. However, you could also find very different situations from your countries. Hope this newsletter would be interesting and useful for you.

We would like to continue publishing the newsletter regularly. Our plan is to publish the newsletter at least once a year. And we could publish it more often, if you send us more contributions. Any kind of information which may be of interest to other geological survey organizations will be accepted as an article for the future volumes of the newsletter. We especially welcome information such as new trends in your organizations and in your countries. A recent brochure to introduce your organization might be OK, if you have no other article. We hope for your contributions to future issues.

We live in the era of electronic communication now. More and more geological survey organizations have their own websites. In order to among the member ICOGS Asia-Pacific organizations through the electronic network, we are also planning to have our own home page to briefly introduce each member organization with links to the existing websites. We would like to have your understanding and cooperation in this matter. We will contact with each organization on this matter.

All correspondence relating to the ICOGS Asia-Pacific including its newsletter should be addressed to:

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ICOGS Secretary for Asia and the Pacific
Geological Survey of Japan
1-1-3 Higashi, Tsukuba, Ibaraki, 305-8567 Japan
Fax: +81-298-54-3589
E-mail: tishi@gsj.go.jp

The third edition of "Directory of Geoscience Organization of the World was published in March 1999, and one copy of the directory was distributed to each organization in the directory. You could see newer information of the directory, which includes corrections after the third edition, in our home page:

[//www.gsj.go.jp/EXT/GsOWDir.html](http://www.gsj.go.jp/EXT/GsOWDir.html).

We would appreciate your suggestions or comments on this directory. We plan to publish the fourth edition in early 2000.

India**GEOLOGICAL SURVEY OF INDIA**

*The following article was submitted to the newsletter by Dr.
D. Haldar, Director, ID of the Geological Survey of India.*

Now we are on the world wide web.

Do visit us at: <http://www.gsi.gov.in>

Your suggestions are welcome.

For more information please contact:

The Director General, Geological Survey of India

27, Jawaharlal Nehru Road, Calcutta 700 016

Tel (91-33) 249-6941/6954/6958/6972/6973

Fax (91-33) 249-6956, e-mail: gsi_chq@vsnl.com



Capabilities and Services available in Geological Survey of India

*PREMIER ORGANISATION OF EARTH SCIENCE STUDIES IN THE SUB CONTINENT
WITH A STRENGTH OF 2900 GEOSCIENTISTS AND TECHNICAL PROFESSIONALS.*

*CUSTODIAN OF GEOSCIENTIFIC DATABASE DEVELOPED OVER A PERIOD OF 150
YEARS.*

*CAPABLE OF HANDLING TIME-BOUND JOBS IN DIFFERENT SUBDISCIPLINES OF
EARTH SCIENCE FROM GEOLOGICAL MAPPING TO DEPOSIT MODELLING.
EQUIPPED WITH MODERN LABORATORIES RUN BY PROFESSIONALS.*

*POSSESSES ORGANISED SET UP TO IMPART TRAINING IN THE FIELDS OF EARTH
SCIENCE.*

HOLDS THE KEY TO MINERAL EXPLORATION.

The GSI has a qualified team of specially trained personnel in the field of geology, exploration geology, mineral analysis, drilling, exploration geophysics, airborne geophysical survey and interpretation techniques, seabed survey and exploration for coal and lignites, with a back up facility of surveying, geodata base and updated versions of computer facility. A synoptic overview of the gamut of GSI's activities, availability of expertise, equipment and services is given in the following pages, GSI can take up work for outside agencies on payment basis after fulfilling its commitments to its own accredited functions.

ORGANISATIONAL SETUP

Ministry of Mines

Shastry Bhawan, New Delhi - 110001

Tel : 334592, Fax: 91-113386402

Director General

27 J.L.Nehru Road, Calcutta-700016

Tel : 2496941/6953/6954/6958/6965/6972/6973

Fax : 91-33-2496956/2441095

Director, GSI Liason Office

A/C-II Block, Pushpa Bhawan, 2nd Floor, Madangir Road, New Delhi 1100062

Tel : 6984956, Fax: 91-116460518

Western Region	Dy. Director General	Fax-91-141-511582
	GSI Complex, 15-16 Jhalana, Dungri, Jaipur-302004	
Op: Gujarat		Fax-91-02712-21199
	GSI Complex, Sector-10A, Gandhinagar-382043	
Eastern Region	Dy. Director General	Fax-91-33-3376290
	CGO Complex, MSO Building, DF Block, Salt Lake, Calcutta-64	
Op: WBSAN		Tel-24960-471-2469830
	4, Chowringhee Lane, Calcutta 700016	
Op: Bihar		Fax-91-612-352479
	Lohianagar, Kankarbagh, Patna-800020	
Op: Orissa		Tel-401171, Fax-91-674-401124
	Unit No. VIII, Nayapalli, Bhubaneswar-751012	
Central Region	Dy. Director General	Tel-524018-4115, Fax-91-712-532636/521671
	GSI Complex, Seminary Hills, Nagpur-14006	
Op: M.P.		Fax-91-0755-565333
	EIS, Arera Colony, Ravishankar Nagar, Bhopal	
Op: Maharashtra (W)		Fax-91-21-2666489
	GSI Complex, Alandi Road, Pune-411006	
Op: MP-II		Tel-314016, Fax-91-761422016
	Sanjivini Nagar Garh, Jabalpur-482003	
Southern Region	Dy. Director General	Fax-91-40-4020958
	GSI Complex, Bandalguda, Hyderabad-500660	
Op: TN & Pondicherry		Fax-91-14-4912782
	A-2-B Wing Rajaji Bhavan, Beasant Nagar, Chennai-600090	
Op: Karnataka & Goa		Fax-91-80-6660670
	'Vasuda Bhavan' Kumaraswamy Layout, Esawar Nagar, Bangalore-560078	
Proj: Kerala		Tel-321244, Fax-91-471-323623
	T.C.24/338, Model School, Road East, Thampanur, Thiruvanthapuram-695014	
Northern Region	Dy. Director General	Fax-91-522-376407
	GSI Complex, Aliganj-Lucknow-226020	
Op: P, H & HP		Fax-91-129-217341
	N.H.5P, N.I.T, Faridabad-121001	
Pr: H.P.		Fax-91-172-702521
	Sector-17C, Chandigarh-160017	
Op: Jammu-Kashmir		Tel-530678, Fax-91-191531750
	2-3 C/C Gandhi, Nagar, Jammu-180004	
North Eastern Region	Dy. Director General	Fax-91-364-230-233
	Asha Kutir, Laitumkhrach, Shillong-793003	
Op: Arunachal Pradeah		Fax-91-3781-22597
	Ganga, Itanagar-791111	
Central Headquarters	Dy. Director General	Fax-91-33249-6956
Op:I, Op:II, Op:III, Geophysics, Geochemistry		
	27, J.L.Nehru Road, Calcutta-700016	
Op:IV, Map, PGRS, Publication		Tel-2497003
	29, J.L.Nehru Road, Calcutta-700016	
Coal Wing	Dy. Director General	
	29, J.L.Nehru Road, Calcutta-700016	
Marine Wing	Dy. Director General	Fax-91-332441095
	4, Chowringhee Lane, Calcutta 700016	
Op: East Coast-II		Tel-54521154729, Fax-91-8913012
	90 Kirlampudi Layout, Viaakhapatnam-530023	
Op: West coast-I		Tel-22294122295
	PVK Bandarkar's Complex, Managuda, Mangalore-575003	
Training Institute	Dy. Director General	Fax-91-40-4022680
	P.O. Mansoorabad, Hyderabad-500660	
A.M.S.E. Wing	Dy. Director General	Fax-91-80-6662595
	'Vasuda Bhavan' Kumaraswamy Layout, Esawar Nagar, Bangalore-560078	

GEOLOGICAL MAPPING:

- * Has built a national geoscience database in the form of 1:50,000/63,360 geological maps covering almost the entire country.
- * Maps are published on scale 1:250,000.
- * The maps are being refined with change in concepts and acquisition of new data.
- * Second generation mapping in 1:25,000 scale being taken up in selected sectors for concept oriented mineral targeting or to resolve specific geological problems.
- * Apart from published maps on smaller scales, ammonia prints of unpublished 1:50,000/63,360 geological maps are made available on request at a nominal cost.

Information available

- (i) Status of completion of geological mapping on different scales, availability of maps.
- (ii) Preliminary investigation reports and unpublished geological maps reports.
- (iii) Pricing and sale of unpublished geological reports.

Contact

DDG Opn. IV, CHQ.
DDG of Regions.
Head of the Opn. units / DDG of the Region/ DDG Opn. III, CHQ Do.

Services Available

Expertise in mapping on any required scale with details to suit the user's needs. (i) Peninsular and shield areas (ii) Himalayan Terrain (iii) Deccan Traps (iv) Quaternary Terrain (v) Thematic mapping

Contact

DDG of the concerned region and DDG of the Opn. unit in the area of interest.

ENVIRONMENTAL STUDIES:

- * Has the necessary expertise and facilities for undertaking various aspects of environmental assessment.
- * Has expertise in land use / land cover mapping from satellite imageries, cadastral maps, in aerial photo interpretation, geomorphological mapping and meteorological data acquisition.
- * Has a division headed by a Director comprising environmental study specialist group in each of the six regions of GSI.
- * Has already carried out environmental hazards zonation mapping in mineral sector and also studies in urban and rural development as well as natural hazards .
- * Since most of the statutory data required for EIA, pertains to geoscience, GSI has an added advantage in the field.
- * Its overall knowledge of ore bodies, their nature and exploration helps GSI in perspective planning of environmental management of mines and waste disposal management.

Services offered

Codification of base line information of geoenvironmental appreciation of any terrain (Pre-Project environmental scenario)

Services

- .Thematic maps, regional and site specific plans for developmental activities as river valley, mining projects, urban development and related EIA & EMP studies.
- .Studies related to annual environmental audit for mines. of Regions.
- .Delineation of hazard zones.

Contact

DG, GSI, Director
(Monitoring) Environment

2) Director Monitoring
(Env), Calcutta.

3) Dy.D.G. Regions

4) Director (Env. Geol.)

MINERAL EXPLORATION:

- * Has a core group of exploration geoscientists experienced in the assessment of different minerals in different settings.
- * Has an excellent track record of augmenting the mineral resources of the country allthrough.
- * Has proved vast reserves of bauxite, dolomite, coal, fertiliser and ferrous group of minerals.
- * Has elaborate infrastructure of drilling, geophysical and analytical stream to back up the detailed mineral exploration work.
- * Facilities for data processing, manipulation and interpretation by computer techniques.

Information available

(1) Mineral Information Dockets

- (a) General Information dossier (GID) on (i) Gold, (ii) Bauxite, (iii) Diamond, (iv) Manganese, (v) Molybdenum ore, (vi) Chromite, (vii) Tungsten ore, (viii) Iron ore, (ix) Copper-lead-zinc ores.
- (b) Detailed information dossier on (i) Bauxite, (ii) Diamond (AP), (iii) Diamond (MP), (iv) Manganese ore (MP, Maharashtra, Karnataka, Goa, Rajasthan, Gujarat), (v) Manganese ore (Orissa, AP, Bihar), (vi) Molybdenum ore (vii) Copper-lead-zinc ores (MP, Maharashtra) (viii) Tungsten ore, (ix) Copper-lead-zinc ores (Kamataka, AP, Tamil Nadu) (x) Copper-lead-zinc ores (UP, Bihar, Orissa, WB, Sikkim), (xi) Copper-lead zinc-ores (Rajasthan, Gujarat)

(2) Progress reports and/or final reports on various mineral investigations (unpublished)

(3) Catalogues of progress reports with approved prices.

(4) Mineral atlas of India & other mineral belt maps

- 1) DDG Opn IV GSI, CHQ
29, J. L. Nehru Road,
Calcutta - 700 016.
- 2) Liaison Office
New Delhi, GSI

Do.

DDG Op III, CHQ
DDG's Office of the concerned
Region/ Wings, Opn. units of
the concerned area
CHQ Sale Counter, Calcutta.
All sale counters of GSI
and Delhi Liaison office.

Services available

- (i) Expertise for exploration of different minerals
- (ii) Exploration for different mineral from preliminary reconnaissance to detailed exploration.
- (iii) From plane table geological mapping to sub-surface exploration by drilling, supported by geophysical and geochemical methods, everything planned and executed by the exploration scientists.
- (iv) Geological modelling assisted by geophysical methods, geochemical data.
- (v) Apart from the above compact packages, the following individual inputs are also offered for mineral exploration or related field.
 - (a) Geological inputs - as preparation of ground plan and geological appraisal, core logging.
 - (b) Geophysical inputs including multisensor logging.
 - (c) Geochemical inputs.
 - (d) Drilling inputs.

Contact

DDG of respective regions.
and DG, GSI, Calcutta

- *Electromagnetic survey . Ground water contamination
.Ground water exploration
.Mineral exploration
.Geological mapping
.Environmental studies
.Urban development
.Archaeology

- * IP survey .Basemetal exploration
.Precious metal and diamond exploration
.Surveys for ground water
.Geothermal resources
.Environmental studies

- * Resistivity survey .Search for base metal, precious metal,
refractories, clay, limestone, building material
.Search of geothermal and ground water resources.
.Glacial mass balance
.Urban development
.Subsurface soil mapping

- * Bore hole logging .Ground water, aquifer parameter
.Mineral investigation
.Site investigation stratigraphic correlation,
void detection, Rock strength. GW
seepage zones

- * Seismic surveys .Ground water
.Mineral exploration
.Eng. studies for dam, tunnel, alignment,
urban development;
.Disposal of hazardous waste
.Overburden thickness
.Velocity zone
.Geol. structures

MARINE SURVEYS:

- * Marine Wing of GSI has more than 300 experienced geoscientists - specialised in various marine fields and can take up sea bed survey with its research vessel and two coastal launches.
- * Has carried out sea bed mapping of 1.2m sq. km of EEZ including about 9000 sq. km of territorial water of India.
- * Has located heavy mineral placer deposits which are exploitable with available technology.
- * Has a rich experience of applied studies/survey related to coastal geotectonics, current observations, placer location, port development and expertise to meet the specific demand oriented needs of the sponsor.
- * The Marine Data Centre is a well equipped computer set up of DOD housed in Marine Wing, Calcutta which is a central data bank on ocean related geological parameters with need based retrieval system for on line/off line data exchange.

Equipment and Machineries:**Research Vessel****RV SAMUDRA MANTHAN***** Samplers:**

- .Bottom grab
- .Gravity/Piston/spade corer
- .Different types of dredges
- .Nansen bottles with reversing thermometers

*** Scientific Equipment:**

- .Dual Frequency echo sounder (3.5 and 12 KHZ)
- .Dual Channel Side-scan Sonar
- .Marine Proton Magnetometer
- .Pinger
- .Self contained chemical wet dry Lab and petrology/palaeontology Lab
- .Global positioning system
- .Under water camera with strobe

Coastal Launches**RV SAMUDRA KAUSTUBH & RV SAMUDRA SHAUDHIKAMA***** Samplers:**

- .Grab sampler
- .Piston corer
- .Box corer
- .Vibro corer
- .Nansen bottles with reversing thermometer

*** Scientific Equipment**

- .Nine element towed sparker system with hydrophone streamer on winch
- .G811 Marine Magnetometer with analogue recorder interfacing to computer and winch
- .Record Annotator
- .Side Scan Sonar System with EPC recorder
- .Under water TV camera with under water/frame video recorder and frame monitor.
- .Depth recorder with digitiser
- .Sub bottom profiling system
- .Current meter
- .Global positioning system (Trisponder system with 542 DDMU, +-1 m accuracy).

Information available

Unpublished progress reports on 84 cruises by Samudra Manthan and 87 cruises by research vessels, the former containing bathymetric, magnetic and sediment characteristic data and the latter including bathymetric, shallow seismic, side scan sonar and geotechnical data (for sale after clearance from Ministry Of Defence and Survey Of India)

Contact

Dy. D.G., Marine Wing, Calcutta.
Director (TCC), Marine Wing Calcutta.
DIC (Marine Wing), bathymetric
DIC (Marine Wing), Mangalore.

Services available

.Sea bed geological mapping with sub surface data up to 30 m depth along with geophysical, geochemical and other thematic maps.
.Investigation for placer minerals in the continental shelf.
.Survey for off-shore structures like single Buoy Mooring system (SBM), drilling platforms and jetties.
.Survey for development of ports and harbours.
.Survey for laying under water pipe liner and cables.
.Survey for selection of sites for disposal of dredge spoils.
.Survey of estuary and coastal areas for non-conventional energy resources.
.Environmental impact assessment.
(Pollution hazards in and around coastal domain)

Contact

Dy. D.G. (Marine Wing), Calcutta.
Director (TCC), Marine Wing
Calcutta.
D.I.C. (Marine Wing),
Visakhapatnam.
D.I.C. (Marine Wing), Mangalore.

AIRBORNE GEOPHYSICAL SURVEYS:

- * Airborne Mineral Survey & Exploration (AMSE) Wing of GSI has been actively engaged in operating multi sensor airborne surveys since 1986 with its own integrated airborne geophysical system.
- * It has carried out multi sensor surveys over an area of 93674 sq. km. (191,929 line km) in selected blocks.
- * It has carried out Aeromagnetic surveys over an area of 119,224 sq.km (45,542 lkm)
- * It had successfully catered to the needs of the user agencies by carrying out:
 - .Aeromagnetic survey over 49,160 sq. km. in N.E.Region and 30,000 sq. km in West Bengal, Assam and foothills of Himalayas for ONGC.
 - .Aeromagnetic (also EM and radiometric in parts) for Oil India Limited.
 - .Magnetic spectrometric survey in Vijay Durg, Maharashtra for Nuclear Power Corporation.
- * It is at the verge of completion of its 15 years project 'National programme of aeromagnetic surveys' in collaboration with NRSA aimed to bring out a national regional magnetic map for all areas except Himalayas, Indo Gangetic plains and Deccan Trap covered areas.
- * It has a team of geoscientists with three decades of experience in airborne survey and who are well versed in the state-of-the-art technology in data acquisition, processing and interpretation who can execute jobs to meet the demands of the user.
- * It can carry out High Resolution Aeromagnetic Surveys at low altitudes and close line intervals.

Equipment:

- * MULTI SENSOR EM-MAGNETIC-RADIOMETRIC SYSTEM FITTED ON TWIN OTTER AIRCRAFT de Havilland with short take off landing capacity. Can fly at low altitude (60 m terrain clearance).
- * Magnetometer: Scintrex V201 oriented cesium vapour magnetometer.
 - Sensor sensitivity 0.005 nT.
 - Sample interval- 5 m in time mode, 10 m in distance mode
 - Resolution- 0.1 nT
 - Compensation- Three coil
 - Navigation system- GPS Doppler and recording on magnetic tape continuous flight path.
- * Electromagnetic system: Tridem- Three frequency (520, 2020 & 8020 Hz) fixed wing, continuous electromagnetic system.
- * Radiometric system: 12 downward and 2 upward looking crystals with total volume of 50 litres capable of measuring broad spectrum of energy levels in 256 channels.
- * Altimeter: Radar 0-2500 feet range 0.5 ft. accuracy; barometric 0 -10,000 feet (amsl) +-5 to 7 feet (accuracy)
- * Data processing centre: The multi sensor data recorded on magnetic tapes is processed at the Geophysical Mapping Centre (GMC) equipped with a dedicated computer system VAX-11/750 with hard disc, tape drive, graphic and non-graphic terminals, CALCOMP plotter, digitiser and printer.
- * Interpretation: The GMC has hardware and software components specially designed to process the magnetic, EM (in three frequencies) and multi channel spectrometric data and give outputs as contour maps or stacked or selective individual profiles.

Information available:

*** Aero geophysical maps**

- .OHR-(1967-68) Magnetic, electromagnetic and radiometric (total counts) 1:30,000/35,000
- .BRGM/CGG-(1971-72) EM interpretation maps (1:1,000,000) aero geophysical maps (1:253,440)
- . NRSA - (1981-84) Magnetic maps (1:50,000/250,000)
 - (1985-88) Magnetic maps (1:50,000/250,000)
- . NGRI - (1978-82) Magnetic maps (1:63,360/250,000/500,000)
- . Twin Otter- (1986 onward) Multi sensor maps consisting of magnetic, EM, Th, U, K and total count (6 maps on 1:50,000)

*** Digital Data: Pertaining to multi sensor surveys**

Data given after due clearance from MOD (pricing not finalised)

Contact

Dy. D.G., G.S.I.,
A.M.S.E. Wing, Bangalore.

Dy. D.G., G.S.I.,

A.M.S.E. Wing, Bangalore.

- * Reports (unpublished) - Pertaining to ground geological exploration -do- work carried out by AMSE Wing, GSI on aerogeophysical anomalies - Reports listed in catalogue & priced reports.

Director, AMSE Zonal Offices, Jaipur/Hyderabad/Ranchi/Shillong/Nagpur (of respective area).

Services Available

Multi sensor EM, magnetic and radiometric surveys.

Application:

- .Basemetal, precious metal exploration
- .Delineation of kimberlite pipes
- .Groundwater exploration
- .Radiometric survey
- .Geothermal exploration
- .Shallow sea bathymetric mapping
- .Covered geology mapping

Contact

Dy. D.G., A.M.S.E. Wing, GSI, Bangalore.

COAL & LIGNITE EXPLORATION:

- * In 1845 Geological Survey of India was set up on the recommendation of Coal Committee for systematic survey of coal fields in the country.
- * Exploration for coal aided by drilling started since 1869.
- * Geophysical techniques were introduced in coal explorations during the late nineteen forties.
- * Coal wing of GSI is situated in Calcutta and is headed by a Dy. Director General with a team of professionals of high expertise.
- * GSI with its excellent records in adding coal resources to India can serve the developing countries with geological expertise and technology for coal exploration.
- * Exploration emphasis given to lignite in areas deficient in coal.

Expertise:

- * Geological mapping of coal and lignite basin.
- * Sedimentary basin analysis (basin modelling/palaeocurrent vector/isopach maps).
- * Drilling.
- * Geophysical investigation (borehole electrical logging/gravity, magnetic and HRSS techniques).
- * Application of remote sensing techniques.
- * Computerised data processing.
- * Environmental appraisal of coal mining areas.
- * Assessment of coal reserve and resource evaluation.
- * Laboratory techniques (palynology/sedimentary petrology/coal petrology/ coal chemistry/DTA, TGA and XRF studies).

Information available

- * Unpublished progress reports and maps on different scales pertaining to investigation for coal and lignite in different parts of the country

Contact

Dy. DG, Coal Wing, GSI, Calcutta

Services Offered

- * Regional exploration of coal in different Gondwana basins.
- * Integrated geological, geophysical studies.
- * Regional exploration for lignite in Tertiary basins.
- * Computer aided studies for data analysis and other related studies for locating future potential target areas.
- * Geo-environmental appraisals in coal mine areas.

-do-

MINERAL PHYSICS LABORATORIES:

- * Mineral Physics Laboratories in GSI are well equipped with modern instruments to carry out physical analysis of geological materials.
- * These are located in all the six regions of GSI apart from the one in Calcutta (CHQ) and manned by highly qualified and trained professionals.

Equipment

- * Central Headquarters, Calcutta
- .Philips Holland make automated powder diffractometer (APD) with Pw-1710 system and PC-AT 386.
- .Philips Holland make X-ray diffractometer Pw-1141 (1974 model).
- .I.R.Spectrometer, Parkin Elmer.

- .Single crystal diffractometer CAD-4 from Enrol Honiles, Holland
- .Melter (TA-2000C) thermal analyser.

- .Electron probe micro analyser (MS-46).

Available analytical facilities

Semi quantitative mineralogical analysis of geological and other crystalline substances.

-do-

To distinguish minerals of the same composition having different crystal structure and identification of minerals having amorphous nature. Complete crystallographic data of pure single phase in the form of grain.

Thermal analysis (DTG, DTA and DAC) of geological samples, particularly clay samples. Complete in situ chemical analysis of micro grains of geological samples. Composition micro graph together with elemental distribution pattern with the help of X-ray scanning on micron size area, point scanning on the other hand provides information on composition variation.

Semi quantitative mineralogical analysis of geological and other crystalline substances. Thermal analysis (DTG, DTA DSC) of geological samples particularly of clay samples.

Semi quantitative mineral phase analysis of geological and other crystalline substances

- * Regional Laboratories:
- .Philips Holland make PW-1730 X-ray diffractometer Melter TA-2000 C thermal analyser (Available with WR, Jaipur, NR Lucknow, CR Nagpur. NR has attachment of Pw-1710 software system)
- .Philips Holland make Pw-1730 X-ray diffractometer (Available with ER, Calcutta, NER Shillong)

Services available

- * CHQ, Calcutta Semi quantitative mineralogical analysis of geological and other crystalline substances.
- * SR, Hyderabad Thermal analysis (DTG, DTA, DSC) of geological samples.
- * NR, Lucknow EPMA: In situ non-destructive chemical analysis of micro grain compositional micrograph together with elemental distribution pattern with the help of X-ray scanning on micron size area. Quantitative data collection on micron size grain enable to determine the elemental composition and accurate stoichiometric formula for mineral phase/phases present on the surface area of the sample exposed to the incident beam.
- * WR, Jaipur & Semi quantitative mineral phase analysis of geological samples.
- * CR, Nagpur.
- * ER, Calcutta
- * NER, Shillong

Contact

Dy.D.G., Op:I
CHQ,
Dy.D.G. of regions.

S.E.M.-E.D.X. LABORATORY:

- * GSI has scanning electron microscope with EDX attachment for advanced studies in geological and material science.
- * GSI has qualified and trained officers to carry out the study along with other scientists from the user agencies.

Equipment:**SEM-EDX**

- .Resolution - 4.5 n.m.
- .Magnification - x 3 to 300,000
- .Primary electron beam - Maximum 40 kV.
- .Detectors - secondary electron, back scattered electron (compo and topo), cathode luminescent and X-ray.

Services available

- * Micro analysis
 - . SATW detector (super atmospheric thin window).
 - .Resolution - 130 eV detection.
 - .Detection Range - Boron (5) to Uranium (92)
 - .Detection Limit - 0 to 1%.
 - .Minimum area of analysis 1µm dia x depth.
- * Data presentation - SEM micrographs
 - .35 mm 100 ASA roll films.
 - .Thermal paper video print processor.
- * EDX micro analysis
 - . X-ray spectrum tabular chart of elemental analysis in Wt % and At %.
 - . Negative film to be provided by the user (original cassette, 100/125 ASA, B/W 35mm).

Contact

Dy D G., Op:I, CHQ
 Director-Palaeontology
 Div.-II, CHQ, Calcutta

GEODATA:

- * GSI is setting up a Geoscientific Data Centre in GSI with distributed sub-centres at the Regional Headquarters and a National Centre at CHQ, Calcutta. The programme envisages setting up modern Data Centres equipped with the state-of-the-art higher-end servers, workstations and Pentium-based PCs linked through LAN and data transmissions between centres through network. These sub-centres would serve as information windows, offering access to the databases on commercial terms.

Equipments:

- * PCs including 386, 486 and Pentium-based computers.
- * RISC-based workstations.
- * Peripherals like plotters, digitisers, scanners, laser printers and inkjet printers.
- * Softwares include ORACLE RDBMS, dBASE, MS-WORD, SPSS STATISTICA, Rockware softwares. LOTUS 123, GDM software (from BRGM, France), AUTOCAD, Arc/Info GIS and ERDAS Image Processing software.

Services offered

- * Training on Computer Basics, OS and handling standard softwares for EDP
- * Development of customised application programme.
- * Statistical data processing with generation of 2D and 3D outputs
- * DeskTop publishing
- * System analysis, design and development of databases

Contact

Dy. D. G., GSITI, Hyderabad.

D.G., GSI, Calcutta
 Director (Geodata) CHQ, Calcutta
 Dy. D.G. of Regions

Indonesia

GEOLOGICAL RESEARCH AND DEVELOPMENT CENTRE (GRDC)

The following article is from a recent GRDC's brochure, which Mr. Thamrin Cobrie Amin, Head of Publication & Documentation Division of the GRDC, kindly sent to the editor.

INTRODUCTION

The early geological investigation in Indonesia has been carried out during Dutch colonialism by establishing *Dienst van het Mijnwezen* in 1850 located at Bogor. In 1866 the institution moved to Jakarta (Batavia). Later on, in 1924, the institution moved to Bandung and was known as *Dienst van den Mijnbouw*.

During the Japanese colonialism (1942-1945) the office was called Chisitu Chosayo. After the declaration of independence, the Chisitu Chosayo was transformed into the Mining and Geological Services. Since 1952, it was divided into Mining Service in Jakarta and Geological Services in Bandung.

In 1959, the Geological Services in Bandung was renamed the Geological Survey of Indonesia (GSI). Later on, in 1979, it was known as the Geological Research and Development Centre (GRDC), the technical unit under the Directorate General of Geology and Mineral Resources (DGGMR).

Becoming the national geoscience data centre in the 21st century is one of the GRDC's visions and this must be achieved by a consistent effort through its own research activities and cooperation with other institutions.

Being the national geoscience data centre, GRDC will have an opportunity to provide the best service for a wide variety of users.

Mission of the GRDC is to:

- provide a geological and geophysical data base for the purposes of
 - mineral resources and energy exploration
 - development of infra structure
 - urban development
 - geological conservation and geotourism study
- develop research methods and concepts in the field of geology and geophysics
- earthquake geological hazard mitigation

Fundamental tasks and functions of the GRDC are to:

- formulate research and development plans and programs in the field of geology and geophysics
- perform geological and geophysical mapping throughout the land area of the Indonesian Archipelago
- carry out research in geology, geophysics, Quaternary geology, seismotectonics, and mitigation of earthquakes
- manage cartography, publications, the geological museum, the library and data acquisition

Implementation of its task and function according to the directive of the Minister of Mines and Energy No. 1748, 1992, GRDC is facilitated by one administrative and five technical divisions.

INTERNATIONAL COOPERATION

Collaboration with institutions from other countries has been undertaken in various aspects of geological and geophysical research, as listed below:

British

The cooperation covered geological and geophysical mapping and research in Sumatera and the Banda Arc. The institutions comprise the British Geological Survey (BGS), GETECH (UK), British Council, etc.

France

This country has collaborated with GRDC in neotectonic studies and geological research in the Western and Eastern Indonesian Regions. Institut National des Sciences de L'Univers (INSU), Centre National de la Recherche Scientifique (CNRS), Universite P & M Curie and Universite P. Sabatier have been involved.

The Netherlands

The type of cooperation work with The Netherlands was the study of Quaternary geology as well as paleontology, especially with the Netherlands Institute of Applied Geoscience TNO.

Japan

The Government of Japan represented by the Japan International Cooperation Agency (JICA), National Science Museum of Japan, and Japan Geological Survey has collaborated in geological research such as Quaternary geology, geological hazard and risk, and the geological museum.

Australia

The main type of cooperation with Australia includes geological and geophysical mapping, mineral resources study, fission track study in many parts of the Indonesian Region (Sumatera, Kalimantan, Sulawesi and Irian Jaya), improvement in the personal's skills and basic geological and geographic information system. The institutions comprise BMR (Bureau of Mineral Resources, now Australian Geological Survey Organization, AGSO), the Australian Nuclear Science and Technology Organization, the La Trobe University, etc.

America

The Unites States Geological Survey (USGS) has been involved with GRDC in regional geological mapping and cartographic work.

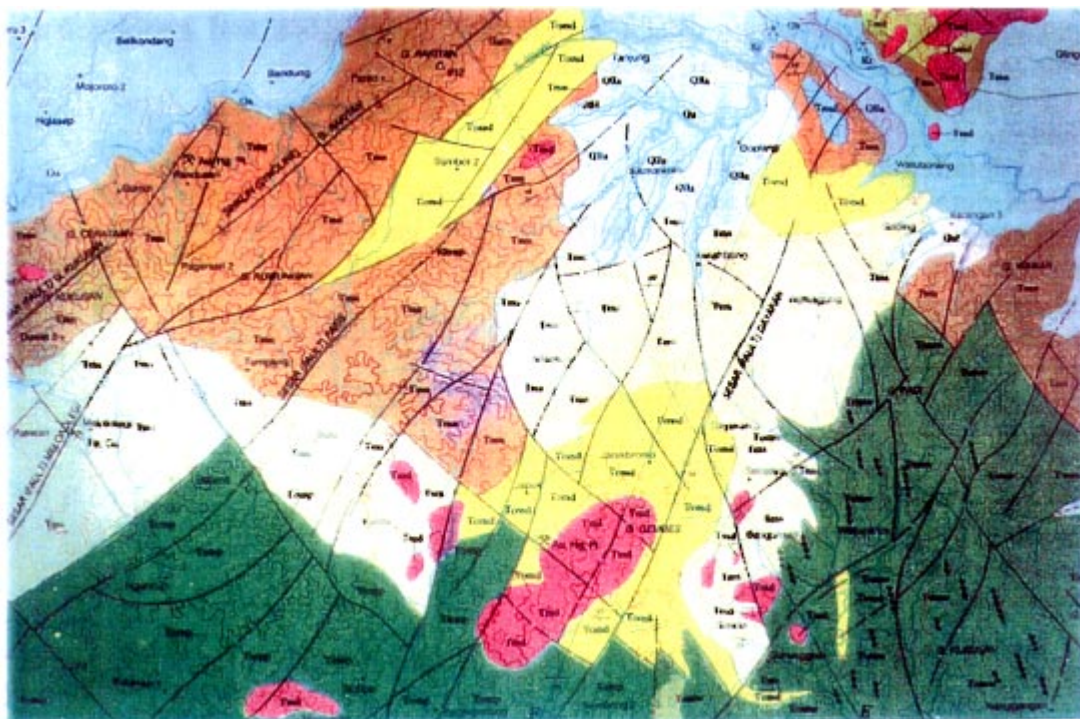
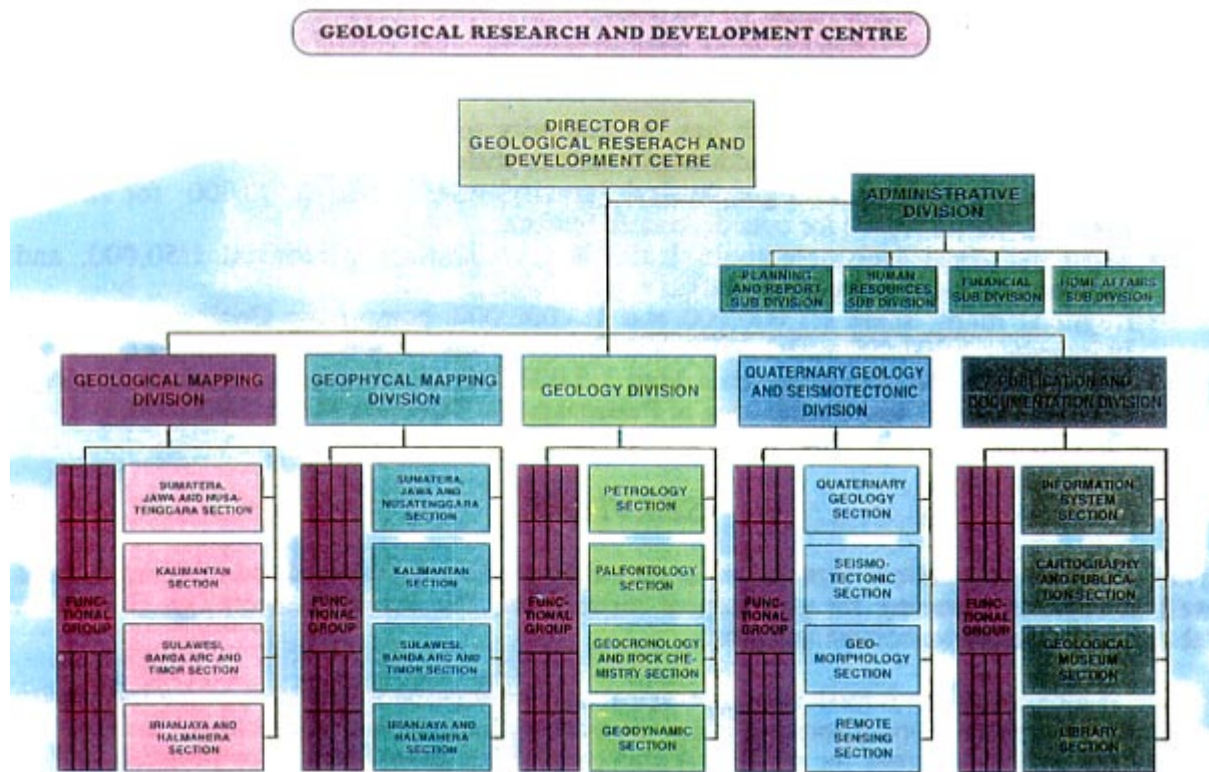
ACTIVITIES**Research**

GRDC is a research centre for investigating all geoscience aspects in the Indonesian Archipelago. This institution has had tremendous experience in carrying out geological and geophysical research and is supported by highly qualified and various geoscience specialists who have graduated (graduate and post graduate levels) from national and overseas universities.

The research activities of GRDC comprise:

- tectonic and geological structure including macro, meso and micro analyses
- basin setting study including sedimentology and seismic stratigraphy, provenance and paleontology
- hydrocarbon and coal studies including source and reservoir rock analyses
- magmatism and petrogenetic studies
- mineralization for ore mineral study

Organization of the Geological Research and Development Centre.



Part of geological map of the Ponorogo Quadrangle, Jawa, scale 1:100,000.

- geophysical study including gravity, seismic reflection, paleomagnetism, airborne geophysics and rock physical analyses
- study of Quaternary geology including coastal analyses, region development plans and paleoanthropological studies
- seismotectonics and neotectonics including earthquake mitigation and risks
- aerial and satellite imagery photo analyses (remote sensing)
- geotourism study and geological conservation

Mapping

GRDC is the only institution which has the authority to produce and publish geological, geophysical, and thematic maps of Indonesia in various scale, including:

- Systematic geological and geophysical (gravity) maps, scale 1:100,000 for Java & Madura, and 1:250,000 for outside Java & Madura.
- Thematic maps (seismotectonic 1:250,000, Quaternary geological 1:50,000, and geomorphological maps 1:100,000) in selected areas.
- Regional maps, scale 1:1,000,000 and 1:5,000,000, comprising Geological Map of Indonesia 1:1,000,000 and 1:5,000,000, Bouguer Anomaly Map 1:5,000,000, Gravity Map 1:1,000,000, Seismotectonic Map 1:5,000,000, Distribution of Radiometric Age Map 1:5,000,000, and Distribution of Paleomagnetic Direction Map 1:5,000,000.

SERVICES

The GRDC has tremendous experiences in providing services for mineral and oil companies as well as regional planning for government institutions. The services encompass fieldwork, laboratory work and associated analyses.

GRDC is also obliged to furnish basic geological and geophysical information of the Indonesian Region. All assistance, collaboration and joint work by national and international institutions, companies and universities for geological and geophysical investigations or research will be considered by our institution.

Fieldwork

The highly qualified and experienced GRDC's personnel (geologists and geophysicists) are readily available to work anywhere around the world.

The work includes:

- regional and detailed geological mapping
- regional and detailed surface geophysical mapping, for example gravity, magnetic and electromagnetic surveys including airborne geophysics, geoelectric and seismic refraction
- sedimentology investigation, including basin setting analysis, environmental deposition, paleocurrent and provenance studies
- tectonics and geological structure studies, including meso and micro structures
- hydrocarbon or fossil fuel investigation
- mineral prospects, industry, building and construction materials investigation
- source and reservoir rocks investigation
- stratigraphic analysis including sequence stratigraphy
- seismotectonic observation and investigation
- geotourism study

Laboratory work

Your samples will carefully be examined and analysed by our skilled staffs using proper and sophisticated equipment and instruments installed in the laboratory section. The laboratory work which is available in GRDC consists of:

Petrology and mineralogy

- thin section and polished or slab rocks
- petrography for volcanic, igneous, metamorphic and sedimentary rocks
- EPMA and XRD analysis - heavy mineral analysis
- grain size analysis - organic petrology
- diagenetic analysis using SEM and XRD in determining pore space, clay matrix and cement, authigenic minerals and framework grain analyses including porosity and permeability of rocks
- fluid inclusion analysis

Geochemical analysis

- whole-rock chemical analysis for major and trace elements

Paleontology analysis

- fossil analysis, including benthic and planktonic foraminiferas, pollen nannoplankton, molluscs and vertebrates

Age dating

- potassium-argon (K-Ar) dating - carbon isotope (C14) dating
- fission track analysis

Geophysical analysis

- paleomagnetism determination - data analysis and geophysical modelling
- geoelectric analysis - physical rock analyses and image processing

Imagery interpretation

unit and geology structure distributions, and regional development plans

Geological Museum

The museum was established in May 16, 1929. It was coincident with the opening ceremony of the 4th Pacific Science Congress. This museum is the only geological museum in Indonesia, which has a total of 250,000 rock and fossil collections and about 2,000 collections are displayed. They are subdivided into four galleries, comprising orientation, the geology of Indonesia, history of life, and geology for human life.

Collections presented consist of various rocks (sedimentary, igneous and metamorphic), crystals and minerals, meteorites, tectites, and fossils including molluscs, vertebrates and hominid skulls, etc.

Other collections are rock samples and fossils collected from the whole Indonesian Region stored in the documentation room. Visitors are welcome to the Geological Museum during workday (09⁰⁰-15⁰⁰), except Friday when the museum is closed. Open on Saturday-Sunday (09⁰⁰-13⁰⁰).

FACILITIES

As a centre of research and in keeping with being a famous old geological institution, GRDC has many facilities required for science research programs.

For supporting field and laboratory activities, GRDC has been equipped with various instruments, such as:

- | | |
|--|---------------------------------------|
| strong motion-accelographs | offset print machine |
| hand auger | static penetration sounding apparatus |
| machine drilling equipments | GPS (portable & geodetic) |
| theodolite | refraction seismic |
| seismographs digital and video cameras | stereo DP2000 analytical plotter |

mirror stereoscope	digital image processor	polarizing microscope
binocular microscope		scanning electron microscope
static mineral separation		point counters & CCTV
argon concentrate determination		gravimeter Lacoste & Romberg
geoelectric		geometrically magnetometer
heating stage (fluid inclusion analysis)		automatic thin section apparatus
fission track		carbon dating (C14)
potassium-argon dating		AAS
electron probe micro analyzer (EPMA)		X-ray diffractometer & SEM

GRDC possesses advanced laboratory facilities. This is the most essential equipment required to support the research and investigation activities. It comprises:

- | | |
|----------------------------|-----------------------------|
| —sedimentary laboratory | —paleontology laboratory |
| —petrology laboratory | —geophysics laboratory |
| —remote sensing laboratory | —Quaternary laboratory |
| —geochemical laboratory | —paleomagnetism laboratory |
| —geochronology laboratory | —seismotectonics laboratory |
| —geotourism studio | —cartography |

Geographical Information System

The geographical information system (GIS) in GRDC is being set up and it will constantly be updated. Principally, this system will be divided into three main divisions, i.e administration, geological and geophysical data and samples collection. The GIS provides all information's concerning geological and geophysical data and maps.

Library

The library of GRDC is the oldest geological library in Indonesia. This library has various geoscientific textbooks and reports, maps, journals, bulletins and magazine collections published from 1800's to the present. The public is also welcome to visit our library.

The library has recently been renovated and more updated data and research results will be collected. Moreover, the library is being linked to overseas libraries by internet service connection.

Publications

The publications of GRDC comprise:

- | | |
|----------------------------|--|
| • geology newsletters | • journal of geology and mineral resources |
| • bulletins | • special publications |
| • paleontology series | • geophysics series |
| • geological maps | • geophysical maps |
| • Quaternary geologic maps | • seismotectonic maps |
| • geomorphologic maps | • geotourism map and brochures |

For further information, please contact:

MINISTRY OF MINES AND ENERGY

DIRECTORATE GENERAL OF GEOLOGY AND MINERAL RESOURCES

GEOLOGICAL RESEARCH AND DEVELOPMENT CENTRE

JL Diponegoro 57 Bandung 40122 Indonesia

Phone: 022-703205 (Hunting)

Fax: +62-22-702669

E-mail: grdc@melsa.net.id

Homepage <http://www.grdc.dpe.go.id>

*Information about Geological Digital Map of Indonesia can be available at the web page:
<http://www.pptm.dpe.go.id/id/> or <http://www.geopoint.com.au/indonesia/>.*

The Information and Thematical Geology Project

The Geological Research and Development Centre (GRDC) has been involved on the five years prime national research project since 1994. The project has been executed and supported by diverse professional geoscientists of GRDC. The objectives have been to assist the government programme and aimed at by contributing new geoscience data and information for regional planning as well as industry sector and economic development on five major selected titles as follow:

Magmatic Evolution of South Kalimantan

The title of this study was selected as a basin knowledge of geoscience in order to reveal the magmatic evolution in the region, especially the Meratus Range. The results of study have not yet been fully conclusive. However, the evidence indicates that the magmatism in the area is very complex in terms of petrogenetics, ages and tectonics. Various types, origins and source of igneous rocks in the area appear to have contributed to the occurrence of variety of minerals, such as gold, iron, chromite, bauxite, manganite, nickel and diamond. The magmatism has also one of the precursor for the oil generation and the rank of coal.

Tectonic Evolution of the Southern part of Sumatera

It was conducted with special on the tectonic framework and its evolution in the region studied. The tectonic evolution of the region has ben noticed since Paleozoic-Mesozoic Era. The result of present study reveals that the region is subdivided into four major terrains:

1)Tigapuluh Mountain, 2)Kuantan-Duabelas Mountain, 3)Asai-Garba; and 4)Gunungkasih—Singkep.

Those four terrains have been bounded by major faults and sutures and suggested to be Paleogondwana origin which have been emplaced at different time. Each terrain has been characterised by several distinctions of geological features and has been believed to have potential sources of mineral and energy.

Stratigraphy of the Southern part of Sulawesi

Sulawesi has been known to be a centre collision of three major plates. Therefore, the rock successions deposited in the area has been closely been related to tectonics. The results of this study have revealed the stratigraphic setting during Tertiary, especially the Toraja Formation, Tonasa Limestone, Makale Formation and other rock units. The successions have also been known to be deposited in different environment and provenance. The characters and features of successions have suggested that the investigated area may have been sources of mineral and hydrocarbon.

Quaternary Geology and Geomorphology of eastern part of Kalimantan

This study has been focused on the geological processes including sedimentation, landscape and geomorphology, geohazard and environment occurring during Quaternary time. During the Quaternary itself, major changes in life and in the physical features of the earth have occurred, even though the period has spanned only about several hundred years. The result of study in the region indicates that sea level changes have occurred and resulted in several formations of depositional facies and stratigraphic cycles. By combining data on drainage, geohazard, construction and industry minerals, shallow groundwater, Quaternary deposits, slope stability and others, Quaternary geological map for urban and regional development planning of the eastern Kalimantan region is presented.

Seismotectonics and Rock Physics of Lombok and Biak Islands

Indonesia has been known to be the most anxious geological hazard including earthquake, tsunami, eruption, flooding and landslide. Therefore, the study on seismotectonics is needed to be programmed in all islands of Indonesia Archipelago. The Lombok Island, Biak Island and other areas have been investigated in this project. The results of research indicated that several geohazard zones have been defined.

Detailed information adressed: GRDC, Jl. Diponegoro 57, Bandung 40122

Phone:(022)703205-208; Fax: (022) 70669 ; E-mail: grdc@melsa.net.id

GEOTOURISM DEVELOPMENT PROJECT GEOLOGICAL RESEARCH AND DEVELOPMENT CENTRE

Background

As a relatively new activity (started in the fiscal year 1997/1998), the Geotourism Development Project was formed to socialized the geological information for supporting the national tourism industry. This activity is performed multisectorally with associated institutions.

Terminology

Some terminologies agreed in the GRDC Geotourism Workshop on March, 16th 1999 have to be understood such as:

- geotourism is the tourism activities in which geological concepts are used to explain the formation of a beautiful scenery as well as the unique and wonder of natural phenomena
- geological conservation is an effort to identify and protect the existence of areas which possess a highly aesthetic natural phenomena due to its geological entity, unique and rarity

Aim and goals

Assisting tourism sector in creating selected nature-based tourism objects becoming the diverse, unique and valuable geotourism objects. These geotourism objects can be used as alternative attraction for travelling.

Products

Up to the fiscal year 1998/1999 the Geotourism Development Project produces some selected products such as:

- geotourism guide book (6 books)
- geotourism maps (3 maps)
- video tape of geotourism objects (6 packages)
- geotourism graphic animation CD-ROM (3 CDs)
- integrated geotourism packages (ordered only)

Aside of 4 geotourism products, the 1999/2000 survey will produce the recommendation of geoconservation in some threatened areas.

Benefit of geotourism products

- diversification and enrichment of geotourism objects.
- geotourism guide book for the tourists guide to explain the natural phenomena using the precise and accurate information
- increasing appreciation of the nature through the comprehension of geotourism
- by increasing the appreciation toward nature as a society habit, the application of geoconservation principal will easily be implemented

Activities in the fiscal year 1999/2000

Geotourism and geoconservation surveys in the fiscal year 1999/2000 will be performed in several areas, such as:

- geotourism of Bayah & Ujungkulon areas
- geotourism of Maros area, South Sulawesi
- geotourism of Lorentz area, Irian Jaya
- geotourism of Kebumen area, Central Jawa
- geoconservation of Gunung Sewu area, Central Jawa
- geoconservation of Gunung Beas area, West Jawa

National Gravity Database System Geological Research and Development Centre

Background

The Geological Research and Development Centre (GRDC) c.q. The Division of Geophysical Mapping (DGM), is one of the founder and pioneer towards the establishment of the National Gravity Commission (NGC). The Commission was founded in 1989. The members of NGC consist of GRDC, Bakosurtanal, Lemigas, Pertamina, BMG, Geoteknologi-UPI, ITB, UGM, Pusurta ABRI and several individual professionals. It has been agreed that NGC is responsible to coordinate, integrate and customize activities related to the acquisition, processing and optimal utilization of gravity data. These also include activities to promote research and development in geosciences by means of building a repository for gravity data acquired from various surveys in Indonesia.

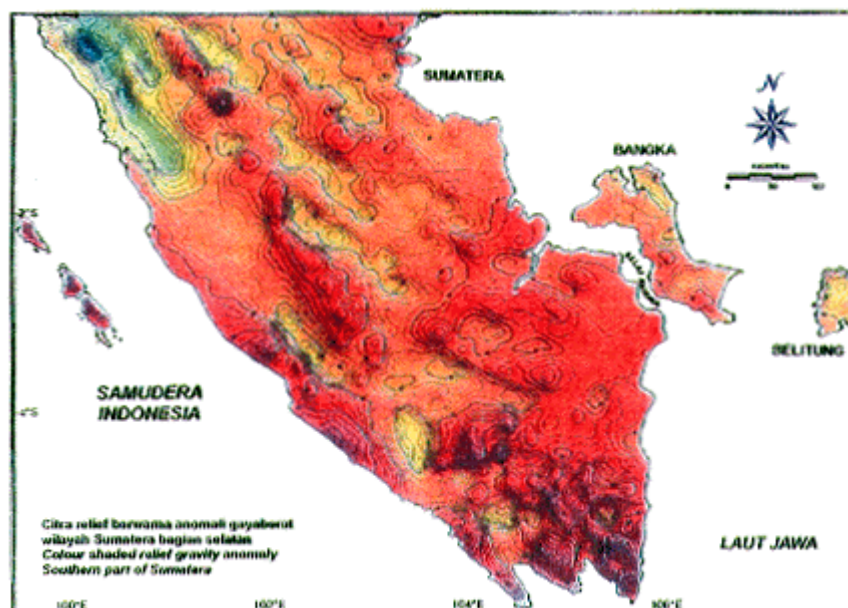
In its development, NGC has established 4 (four) working groups, i.e.

- *Working Group on Gravity Network (WGGN)*
- *Working Group on Gravity Database (WGGD)*
- *Working Group on Geodesy (WGG)*
- *Working Group on Geodynamics (WGGi)*

WGGD forms the core activities, supporting not only the other three groups within NGC but also scientific communities nationwide. Since its establishment, NGC has been maintaining and updating its repository which contains no less than 200,000 land gravity data and about 300,000 gravity data obtained from marine surveys throughout the Indonesian region. In regard with the scope of works of GRDC which covers research and development in geosciences, in January 1998, the gravity database system was transferred from NGC to GRDC. Since then, GRDC c.q. DGM operates and maintains the system.

Geophysical Data Services

In addition to operating and maintaining the gravity database system, DGM also provides services in processing, enhancement and interpretation of geophysical data. Processing of geophysical data comprises two types, i.e. basic processing and advanced processing. Basic processing deals with standard procedures which cover reduction and compilation of geophysical data. Advanced processing deals with filtering and creating colour and shaded-colour presentation. Quantitative interpretation is carried out using model analyses to investigate the geometry of subsurface geological features. Model analyses which are available include the two-dimensional (2-D), the two-and -a-half dimensional (2 1/2-D) and three-dimensional (3-D). For further information please contact Indra Budiman, e-mail address bgfgrdc@melsa.net.id



Colour shaded relief gravity anomaly Southern part of Sumatra

Iran

GEOLOGICAL SURVEY OF IRAN

The following article is from the latest Geological Survey of Iran's brochure, which Mr. M.T. Korehie, General Director of the GSI kindly sent to the editor.



Introduction

The Geological Survey of Iran (GSI) is authorized to carry out geological and mineral investigations throughout the country, to collect results of activities performed in this respect, to establish interrelationship and coordination between such activities and to prepare, complete, and publish geological maps of Iran. In 1962, the Geological survey of Iran (GSI) was established through a special fund project of United Nations. In 1999 the exploration duties of the Ministry of Mines and Metals was totally assigned to the GSI. The GSI is now responsible for the geological study of the country, and the exploration-evaluation of the mineral raw material (except hydrocarbons). This exploration aim is accomplished by the activities of different groups of GSI, such as Stratigraphy, Petrology, Sedimentology, Marine Geology, Paleontology, Tectonics, Seismotectonics, Exploration, Geophysics, Geochemistry, Geomatics and different labs, according to the general directions drawn by the Ministry of Mines and Metals, in the framework of the recently approved "Mining Law".

The GSI also cooperates with other organizations in Iran and abroad through bilateral cooperation or joint research programs.

In order to transfer the geological knowledge and publish new scientific findings, GSI started publishing the Geosciences Scientific Quarterly Journal in Autumn 1992. The Research Institute of GSI, established in 1994, is actively involved in research projects concerning pure and applied geology.

GSI benefits from the services of Toseh Olom Zamin company (TOZCO), which is in association with GSI, for implementation of its tasks.

Specific topics of the GSI's research activities include:

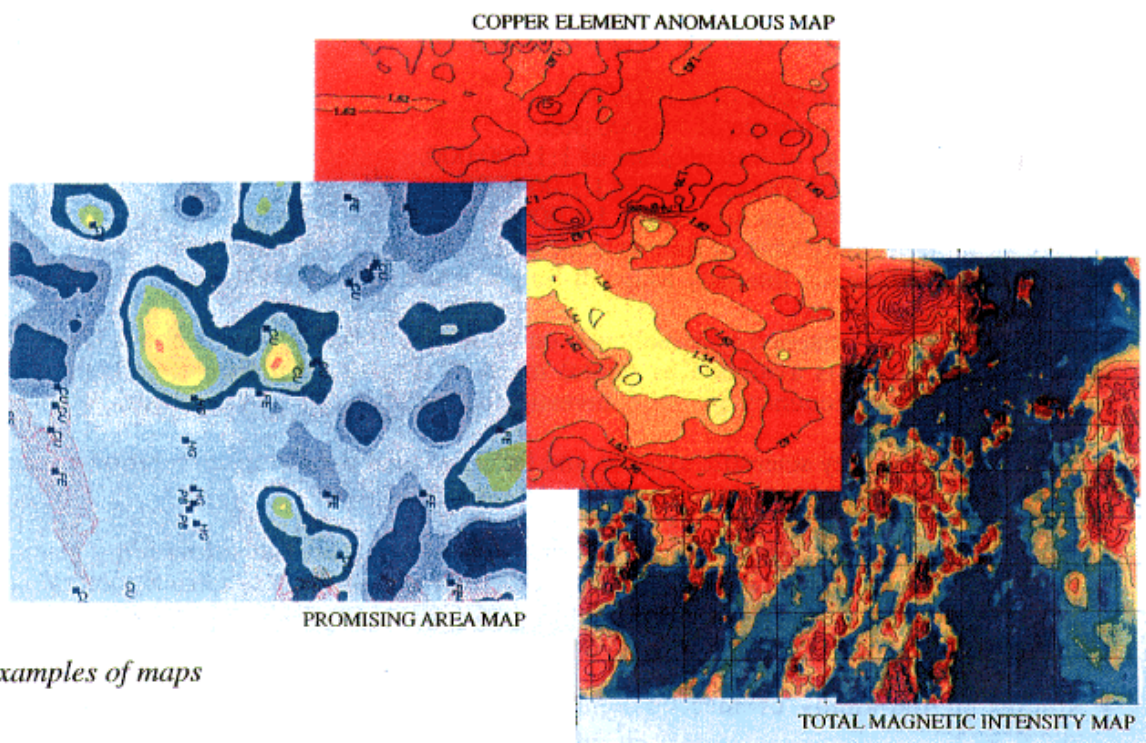
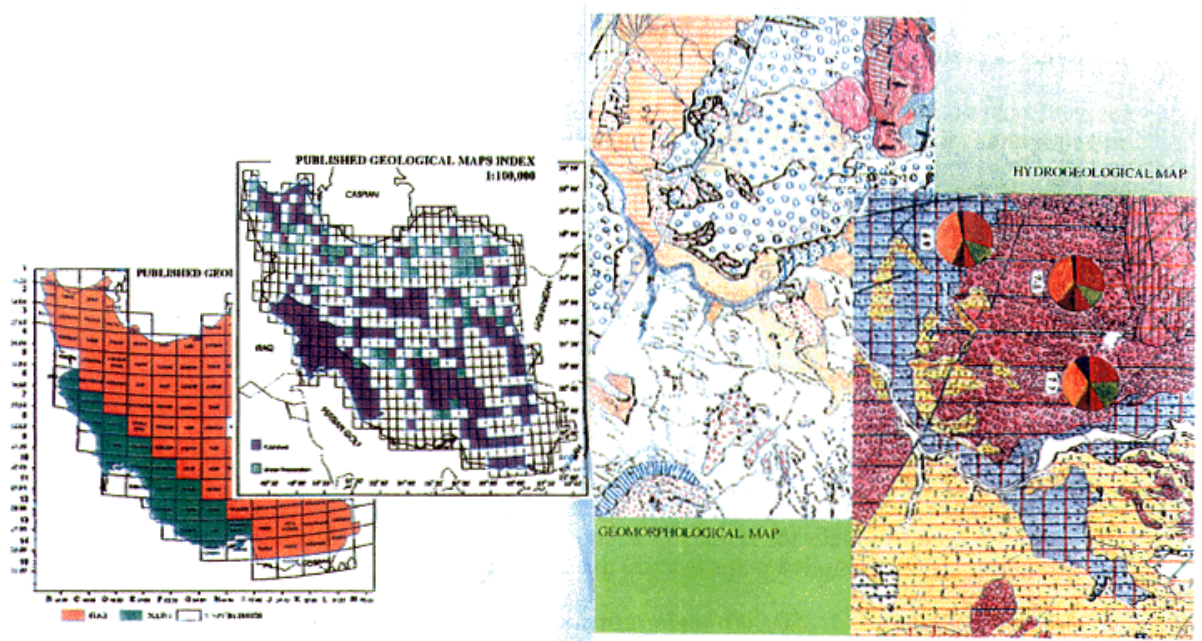
Systematic basic surveys, mainly including the preparation and compilation of the country's geological maps on scales of 1:250,000 and 1:100,000, and the study of its geology, structure, and tectonics.

Carrying out of specialized surveys involving geophysical, geochemical, paleontological, structural and mineralogical methods, resulting, in some cases on the compilation of thematic maps.

Exploration, recording and evaluation of mineral raw material with the aim to develop the country's raw material and energy resources, expanding the industrial basis of country, and encouragement of productive investments.

Investigation and study of geotectonic, tectonic, seismotectonic and environmental problems, which are connected to either catastrophic phenomena (earthquakes, landslides, etc.) or the planning and carrying out of technical and development projects (dams, highways, tunnels, urban planning, etc.).

The accomplishment of the above aims is achieved by different specialized surveys in the field. Specific laboratory studies are carried out either independently or for the completion of the field work. Remote sensing and GIS methods are extensively used in related departments to compile and produce geological and thematic maps.



Examples of maps

The above mentioned studies are also to carry out feasibility studies for the potential economic ore-body resources. A data center (including the library), a computer department, an archive of aerial photographs and topographical maps, a cartography laboratory, a land surveying department are operating as support services at the GSI.

Presently about 700 people are working at the GSI, where their skills along with laboratory and computer facilities are used to carry out research and exploration projects of high quality.

The central headquarters of GSI is in Tehran, and there are five other headquarters in the northwest (Tabriz), northeast (Mashhad), south (Shiraz), southwest (Ahwaz), and southeast (Kemman) of the country. These headquarters carry out local functions of the GSI.

Basic Geological Research

Regional Geological maps

Preparation and compilation of geological maps of country on scales of 1:250,000 and 1:100,000 (geological maps on larger scales are produced where required by special projects). The maps are used as a base for studies in economic geology, pure science, and engineering. The following are the compiled maps that are available at the GSI.

Geological Maps on 1:250,000 scale, covering the entire country are compiled (121 quadrangle maps). The explanatory reports are included.

Geological Maps on 1:100,000 scale, covering about 34% of the country (222 sheets) are compiled, and about 242 maps are now under preparation, which is foreseen to be completed by the year 2006.

Thematic Maps (available both as hard copies and digital)

Tectonic Map of Iran on scale of 1:1,000,000.

Magmatic map of Iran on scale of 1:1,000,000.

Economic Geology Map of Iran on scale of 1:1,000,000.

Orohydrography Map of Iran on scale of 1:1,000,000.

Geomorphology Map of Iran on scale of 1:1,000,000.

Total Magnetic Intensity Map of Iran on scale of 1: 1,000,000.

Total Airborne Magnetic Intensity Maps of Iran on scale of 1:250,000 (flight line spacing of 7.5 km, in three colors).

Geochemical dataset mapped systematically on scale of 1:100,000, covers about 1/3 of the country. The dataset is available as digital maps of single and multiple elements. The remaining parts of the country are being investigated according to their priorities.

In order to solve some key scientific aspects, and facilitate geological and exploration studies, some of the GSI activities are allocated to carry out thematic studies .

- Engineering geology, natural hazard studies, seismicity atlas and introducing seismic areas, and paleontological studies are among the research projects of GSI. Structural and tectonic studies as a base for understanding the geodynamic evolution of Iran.
- Study of important stratigraphic type sections, in order to do regional stratigraphical correlation.
- Studies in the fields of macropaleontology, micropaleontology, palynology and microfacies.
- Study of sedimentary rocks, sedimentary environment, and basin analysis.
- Study of marine and terrestrial sedimentary environments of the country.

- Study of marine and lake environments has been started, and research has been carried out on the sediments of natural lakes, dam lakes, northern and southern coasts, swamps, and rivers. Development of marine geology activities is among the major aims of the GSI.
- Petrographical and petrological study of intrusive, extrusive, and metamorphic rocks for understanding the magmatic and metamorphic evolution of Iran.
- Application of Remote Sensing and GIS methods in preparation structural, geological and thematic maps and mineral exploration.

Exploration and Evaluation of Ore Deposits and Industrial Minerals

The exploration studies of the GSI is carried out on the basis of the four following stages: Reconnaissance studies, prospecting, general exploration and detailed exploration.

The Reconnaissance studies are done through integration of topographic, geochemical, airborne geophysical, satellite, geological, and mineral distribution data within the GIS environment. Other specific software is used to compile the dataset, modelling, and finally define promising areas.

The prospecting, general exploration, and detailed exploration stages for promising areas are carried out according to the following figure.

- Sampling, recording, classification, and evaluation of metallic and nonmetallic mineral deposits, and study of their relationship to the geological setting.

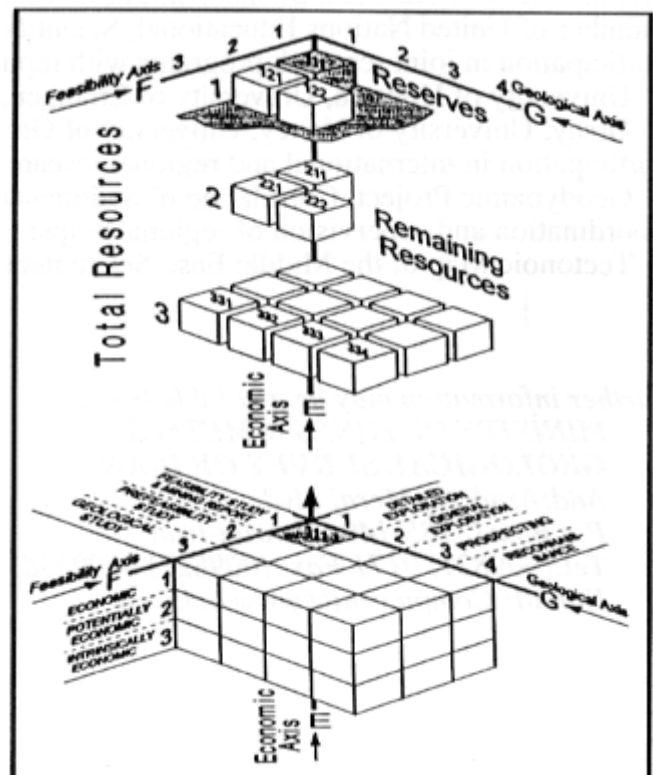
- Determination of areas with a high probability of hosting mineral deposits.

- Locating of metallic ore deposits and industrial minerals by using modern exploration and mining methods.

- Qualitative and quantitative studies of ore bodies of metallic raw materials, industrial minerals and estimation of their reserve potential by applying geostatistical and other evaluation methods.

- Feasibility studies for exploration of metallic and nonmetallic raw materials.

- Application of laboratory methods to study the composition, purity and origin of the economic minerals.



Some of exploration activities, which are in their final stage or are being exploited are: Exploration of bauxite, phosphate, magnesite, potash, alunite, gold, nepheline syenite, asbestos, titanium, tungsten, copper,...

Laboratory studies

Chemical analyses of major and trace elements on geological rock, soil and water samples.

- Petrochemical analyses (major and trace elements).
- Study of clay minerals.
- Microprobe analyses on minerals and ores.
- Testing qualitative and quantitative parameters of soils.
- Testing material strength.

Modern analytical laboratories:

X - ray diffractometer
Electron microprobe
X-ray fluorescence spectrometer
Infrared spectrometer
Transmitted and incident light microscopes
Emission spectrometer

Bilateral cooperation & Joint Research Programs

Member of the Commission for Geological Maps of the World (CGMW).

Member of International Union of Geological Sciences (IUGS)

Member of International Geological Correlation Program (IGCP)

Member of Economic and Social Commission for Asia and the Pacific (ESCAP)

Member of United Nations Educational, Scientific and Cultural Organization (UNESCO)

Participation in joint research programs with reputable universities of the world:

University of Uppsala, University of Erlangen, University of Munchen, University of Orsay, University of Nancy, University of Grenoble, University of Salzburg.

Participation in international and regional research programs: Geotraverse Project, Geodynamic Project, Correlation of Sedimentary Basins (ESCAP region).

Coordination and supervision of regional maps: Geological Map of the Middle East,

Tectonic Map of the Middle East, Seismotectonic Map of the Middle East.

Further information may be available from:

MINISTRY OF MINES & METALS

GEOLOGICAL SURVEY OF IRAN

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Lao People's Democratic Republic

DEPARTMENT OF GEOLOGY AND MINES

The following article was submitted to the newsletter by Mr. Bountheung Phengthavongsa, Director General of the Department of Geology and Mines.

MINERAL RESOURCES DEVELOPMENT IN LAO PDR

by B. Phengthavongsa

Lao People's Democratic Republic having a surface area of 236,800 square kilometers is well endowed with mineral resources. Although the territory of Lao PDR has not been systematically prospected or explored by modern methods, deposits and ore occurrences of a wide variety of metals, non-metals and precious minerals are known.

At present mineral production is relatively limited to small quantities of tin, gypsum, coal, constructional raw materials, barite and sapphire for export. Therefore the Lao government has ranked mineral and mining development as one of its rural priorities .

I. Government Organizations in the Mineral Sector

The Department of Geology and Mines (DGM) established in 1975 is a component body of the Ministry of Industry - Handicraft (MIH) and currently employs 75 staff, of which 25 are geologists and 30 technicians.

According to mining law, adopted by the president of the Lao PDR, dated May 31, 1997 the Department of Geology and Mines has the main role in geological mapping, mineral exploration, providing geoscience services required by other government agencies, international organizations and private mining companies. It also assists the MIH to negotiate all mining contracts and to issue all exploration and mining licenses. All mineral resources are owned by the State and mining activities by private companies are regulated by the Ministry of Industry - Handicraft via the Department of Geology and Mines.

The DGM is composed of five divisions (figure 1): Administrative Division, Mining Concession Division, Geological Division, Geo-information Center, Mineral Analysis Center and Geological Survey Group.

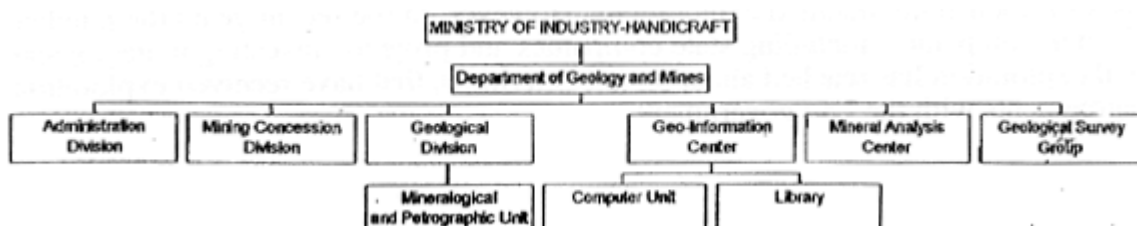


Fig.1 Organisation of the Department of Geology and Mines of Lao P.D.R.

DGM work focuses in the following areas:

- 1:200 000 geological map production,
- Exploration for fuel minerals (coal),
- Exploration of industrial minerals in particularly construction minerals,
- Promotion of geological exploration and mining production closely linked with agro-forestry : Raw materials for biofertilizer production, etc...
- Strength of the capacity of DGM staff: Training in environmental regulations and management, in remote sensing, in analysis of environmental samples, in field geology and mineralogy,
- Investment promotion of local and foreign companies in mineral and mining activities,
- Profit from the cooperation and assistance from other countries that have potential finances and professional experience.

II. Mineral activities

The first geological reconnaissance in Laos was undertaken by the French geological Service of Indochina in the period 1900 - 1940. In this period almost the whole country was prospected and explored by outmoded machinery or hand-made machinery of the French colonialists. Therefore many ore occurrences and mineral deposits have been found in every part of the country.

In the 1950s and 1960s there were many mineral exploration projects assisted by France, the United Kingdom, the United Nations and Japan. Because of the Indochina war, which made the region insecure and did not allow for any geological work, some of these projects could not be achieved or completed.

Since the foundation of Lao PDR, especially in the period 1975-1985, the geological technical cooperation and assistance was developed by the URSS, Czechoslovakia, Bulgaria and Vietnam. The exploration targets were directed towards evaluating geological basic data (dimension, quantity, quality of ore occurrences or mineral deposits) for local and foreign investment in the future.

From 1986 the Lao PDR has reformed the economic policy. It has changed from the subsistence and semi-subsistence economy to a commodity economy / market economy based on the new economic mechanism. From this year the geological technical cooperation and assistance of socialist countries has been step by step decreased, but it has been increased by many countries having different political regimes.

As a result of our efforts in geological prospection and exploration with the cooperation and assistance from other countries, since the beginning of this century in the whole territory of Lao PDR there have been about 480 discoveries of ore occurrences and mineral deposits. They include precious metals, base metals, tin, tungsten, minor metals, ferrous metals, precious and semi-precious stones, industrial minerals and evaporite. Most of these mineral resources have not been clearly explored yet, so as to get the geological information and persuade the investors to come to Laos for their more detailed explorations. However, in the recent years the number of local and foreign companies (including state companies and projects) investing in geological prospection and exploration has reached about 53 (81 activities), that have received exploration licences and agreements with the Lao government.

III. Mining activities

As described mineral activities above in the whole territory of Lao PDR have been found various types of ore occurrences and mineral deposits, of which most have not been clearly studied yet because of lack of funds to study, and because of their geological conditions. However, some of them are under detailed explorations, and a few enterprises / companies receiving exploitation licences after their geological detailed explorations have exploited their concession areas. The present mining activities that have produced and exported their raw materials are as follows

- There is one gypsum mine at Dong Hene (Savannakhet province) exporting to Vietnam about 130,000 tons / year.
- Two tin mining operations (including the Russian-Lao and Northern Korea-Lao joint ventures in Nampathene valley of Khammouane province) have produced tin concentrate exporting approximately 550 tons/year.
- There are also some small coal mining operations: Vieng phukha lignite of Luangnamtha province and Bochan anthracite of Vientiane province that have been exploited, exported to Thailand and supplied to VangVieng cement plant annually, about 200,000 tons.
- Two small barite mining operations (at Fuang district of Vientiane province) have been produced and exported to Thailand, about 8,000 tons/year.
- In addition there are precious gems (sapphires) mining in Borkeo province and some gold deposits exploited in artisan operations.
- Besides the mining operations above, there are also some small scale quarries of industrial minerals and decorative rocks, such as limestone, sand, basalt, gravel, granite, etc. for construction purposes.

IV. Status of Geoscientific Data

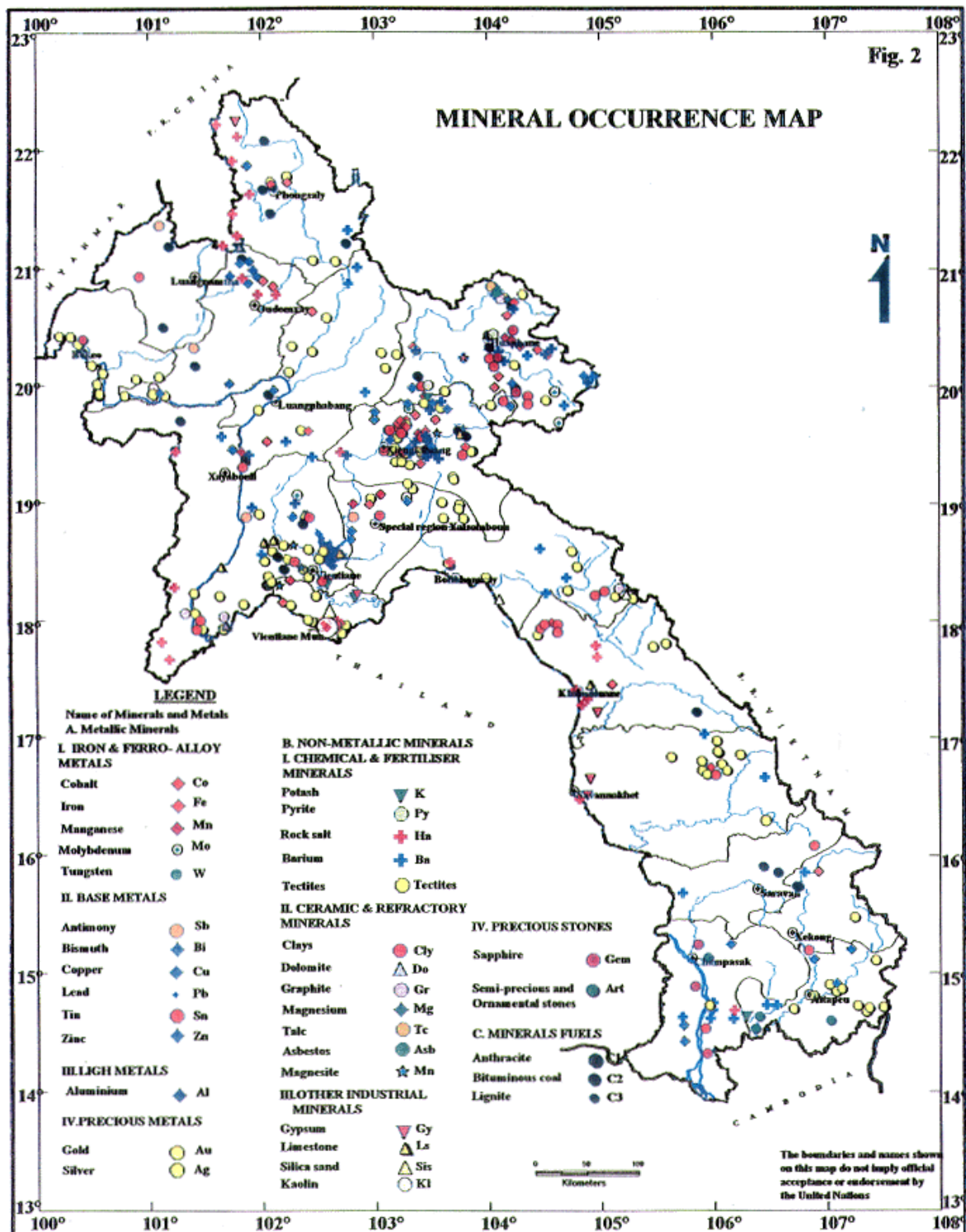
As described mineral activities above, with geological technical cooperation and assistance from other countries the geochemical surveys were conducted in several phases by Lao and foreign geologists such as French, Russian, British, Japanese, etc. from 1960 to 1990.

In the period of 1974 to 1988, geologists from the Vietnamese General Department of Mines in cooperation with DGM geologists undertook geological mapping at scale 1:200,000 in Vientiane area (7,372 km²); Khangkhay area (8,150 km²), part of Xiengkhouang province and Samneua area (9,480 km²). At present this work is carried out in 29800 km² at the middle part of Lao P.D.R.

The three latest geological maps are the 1:1,500,000 geological map, the 1:1,500,000 mineral map published by the Economic and Social Commission for Asia and Pacific (ESCAP) in 1990, and the 1:1,000,000 geological and mineral map produced by the British Geological Survey (BGS) in 1991.

The area surveyed by airborne magnetic method covers about 30% and by airborne radiometric 25%.

Recently, geological mapping at larger scale was carried out by the DGM under the UNDP technical assistance project and by private mining companies over their concession areas.



V. Mineral Potential and Development

Despite the limited scope and coverage of the country by the geological mapping, geochemical and geophysical surveys, Lao PDR has potential in a wide variety of metallic and non-metallic minerals such as gold, copper, lead, zinc, iron ore, tin, coal, industrial minerals and gemstones. There is a total of 480 discoveries of ore occurrences and mineral deposits, which are shown on the 1:1,000,000 mineral occurrence map produced by the ESCAP in 1990. Figure 2 shows the mineral resources of Lao PDR.

Mineral development has been small in terms of mineral exploited (gold, tin, gypsum, coal, construction materials and gemstones) and scale of mining. Although many deposits such as the cassiterite deposits at Nam Pathene (Khammouane province), the gypsum deposit at Donghene (Savannakhet province) have been known and work for several years, none has become into a prosperous mining industry. Mining activity is limited because of lack of funds for some geological work improvement, and because of the inadequate experience and capacity of Lao staff in the mineral sector.

Gold

Alluvial gold occurs in many areas of Lao PDR as small deposits and is exploited on a small scale by local artisanal groups and by junior companies. Gold is panned from the Mekong river and its tributaries over most of the country. Hard rock gold sources are relatively unexplored, but many large areas show gold potential for bedrock deposits related with Permian -Triassic intermediate to silicic rocks. A foreign mining company is now exploring gold in the centre part of the country.

Copper, Lead and Zinc

Lead and zinc occur as high grade quartz vein fillings in Vangvieng, 150 km north of Vientiane. Porphyry copper mineralisation is possible in Xiengkhouang province, where copper skarns are favorable exploration targets. Veins and breccia fillings of covellite, chalcocite, chalcopyrite and secondary copper minerals occur in Nam Pak, northwest of the country.

Iron Ore

The iron ore prospects of potential economic interest are located in Xiengkhouang province, in the north centre of the country, of which two - Pha Lek and Phou Nhuan are considered to have economic importance. Reserves are estimated to be 60 millions tons for Phou Nhuan. The ore is high grade (up to 70%) and mostly composed of magnetite and hematite.

Tin

Tin deposits occur in the Nam Pathene valley, Khammouane province. The principal ore is Cassiterite and the mineralized area extends over 22 square kilometers. Reserves are estimated by the Soviet geologist team (1979-1987) to be 112 million tons of ore graded 0.2 % Sn. There are four mines, of which two - Boneng and Nong Sun mines are currently in production.

A belt with potential tin - tungsten - antimony deposits is situated in Louangnamtha, northwest of Laos. It is the continuation of the Chiang Mai - Chiang Rai tin - tungsten belt of Thailand. Houaphan and Xiengkhouang provinces also have potential in scheelite.

Coal

Coal is known in many regions of the country. The Chakeui coal deposit in Salavan province is considered to be the most important. The inferred reserves are estimated to be about 40 million tons. The Hongsa coal basin in Sayaboury province and the Muong Ngeun lignite deposit are currently mined by Thai companies. The Bo Chan coal deposit in northwest of Vientiane has a reserve of about 5 million tons and is in production by a State Mining company.

Other lignite occurrences are present in Houaphan, Xiengkhouang and Sayaboury provinces.

Industrial Minerals

Huge deposits of gypsum is located in the Mesozoic evaporite basin of Savannakhet. Proven reserves are estimated to be of 18 million tons. Present production is undertaken by the State Mining Enterprise for Gypsum and exported to Vietnam.

A large potential potash deposit lies in the Vientiane Plain. Potash reserve is estimated in the range of 50 billion tons with 850 billion tons of halite and 12 billion tons of gypsum.

Extensive limestone and dolomite sources are found in many provinces in particularly in Khammouane and Vientiane province. Limestone at Vangvieng (Vientiane) is now extracting for cement manufacture.

Local granite and marble found in many parts of the country could furnish material for construction and road construction.

Gemstones

Lao PDR has good potential for sapphire and amethyst. Sapphire placers at Ban Houei Xay, Bokeo province have a long tradition of artisanal mining by local people. Sapphire is ourently producing by two foreign mining companies.

Amethyst is present in vugs and fissures in Triassic rhyolites in Champassack province.

VI. Conclusion

The Lao PDR is a small landlocked country which has plenty of natural resources. Although Lao PDR is rich in natural resources, the Lao people are poor. We need to exploit this resource for bringing Lao people to a good level of life. Due to our richness in natural resources, we expect that, in the future they will be exploited and Lao PDR as other countries will be led to civilization by these natural resources.

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Nepal

DEPARTMENT OF MINES AND GEOLOGY

The following article was submitted to the newsletter by Mr. N.R. Sthapit, Director General of the Department of Mines and Geology.



Department of Mines and Geology (DMG), Nepal: An Introduction

Origin of the Organization

The Department of Mines and Geology was created in the year 1976. It is the only government organization dealing with geo-scientific investigation, studies and mineral resources development in the country. The department has a long history of its origin since its first emergence as an "Office of Irrigation and Geology" in the year 1929. In 1942, after separation from its parent institution it was renamed as the "Office of Mines" which was ultimately expanded to a departmental institution called "Bureau of Mines" in the year 1961. From this dimension, it has further expanded its activities towards fulfillment of needs of the diversified geo-scientific services in the country. In 1967, His Majesty's Government of Nepal has created one more separate institution named as "Nepal Geological Survey". In 1977, both of these above organizations were amalgamated and renamed as the "Department of Mines and geology".

Mandate of Organization

The Department of Mines and Geology was established with the objectives of

- Promoting the minerals sectoral development through provision of sound mineral policy and laws ultimately to uplift the national economy.
- Acquiring and delivering the basic geo-scientific information and expertise services to mineral resources exploration and development entrepreneurs, and institutions involved in infrastructure development, mitigation of natural hazard and protection of environment.
- Regulating and monitoring of mineral exploration, mining and mineral-based industries.

Status of Geo-scientific Studies and Mineral Resources Development

The Department of Mines and Geology exercises her duties and responsibilities through the three divisions namely Geo-sciences, Mineral Resources, and Technical and Administration Services. Eleven sub-divisions and 41 sections having specific functions are actively involved under the above divisions to achieve the goal of the organization.

Presently the activities of the department cover five major fields of studies such as geo-scientific survey, microseismicity study and earthquake monitoring, mineral exploration, petroleum exploration, engineering geology and environment.

Geo-scientific Survey and Research

Out of the total 147,181 sq. km areas of the country, 162 quadrangle geological map sheets at a scale of 1:63,360 covering 105,000 sq. km area are available in the DMG. Out of those maps a few geological map sheets had been updated and published in multi-colors. The DMG has a plan to update and publish the geological map sheets for the whole country. Geological maps of Nepal are also available at the scales 1:250,000, and 1:1,000,000.

Microseismicity Study and Earthquake Monitoring

The current National Seismological Centre of the DMG since its establishment as the "Seismological Laboratory" in 1978 has been acquiring data on seismic event of magnitude as low as two occurring in any part of the country. The National Seismological Centre makes use of the seismic recordings observed in the National Seismological Network which consists of 21 seismic stations distributed in the Lesser and Sub-Himalayan terrain of the country. Based on these information, the DMG has prepared and published the "Microseismicity Epicentre Maps of Nepal" at a scale of 1:1,000,000 and 1:2,000,000.

Mineral Resources Development

Three Cement Industries and one each of the industries based on magnesite, talc, marble and agriculture lime are existent in Nepal. The DMG has awarded recently two limestone deposits of Surkhet and Arghakhanchi for the feasibility study and establishment of cement industries. One more cement grade limestone deposit has been proved recently at Sallyan. The establishment of cement industries in Nepal has a great potentiality as the current production fulfills nearly the half of the current demand.

Petroleum Exploration and Promotion

The DMG has divided the southern Terai Plain and the Siwaliks of the country into ten different blocks of nearly 5000 sq. km. area each for the purpose of the petroleum exploration and promotion in Nepal. Potential investors can acquire the block for petroleum exploration after fulfilling the bidding system outlined by Petroleum Act and Regulations. Seismic option and "No Ring Fencing" of blocks are prime incentives.

Engineering and Environmental Geology

Although the application of geology in the infrastructure is considerably historical in Nepal, the awareness on increasing needs of the geological services in environmental protection and mitigation of natural hazard has emerged recently. The DMG initiated the delivery of services in this field by preparing the engineering and environmental geological maps for the urban areas of Kathmandu and Pokhara valleys in 1994. The DMG has a plan to conduct similar studies in other urban areas also on priority basis. It provides engineering geological services to concerned organizations and individuals on demand.

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New Zealand INSTITUTE OF GEOLOGICAL & NUCLEAR SCIENCES LIMITED

*This introductory article was sent by Ms. Susannah Sharpe,
Strategic Analyst of GNS.*

The Institute of Geological & Nuclear Sciences Limited (GNS) is New Zealand's leading supplier of earth and isotope scientific research and consultancy services. We are a government-owned research company and our services and products benefit a wide range of private sector companies, government organisations, and research groups in New Zealand and internationally.



Activities include resource evaluation for the petroleum exploration industry, assessment and mitigation of geological hazards, geological mapping, engineering geology, marine geology, geophysical surveys and investigations, assessment and development of geothermal fields, assessment of mineral resources, assessment of groundwater quality and quantity, resource management services including analysis of contaminated sites, and the application of isotope sciences to age dating, and to the medical, environmental, and manufacturing industries.

GNS has 260 staff based at research centres in Wellington, Wairakei, and Dunedin. Its library, databases, and fossil collections are of international importance. It has nine client focused sections - Hydrocarbons, Geothermal & Minerals, Groundwater, Earthquakes, Volcanoes, Active Landscapes, Mapping, Isotope Applications, and Geological Times.

Our main industry linkage and clients include:

dairy processing industry	engineers and developers
electricity, gas, and telecommunications companies	
environmental and land management industries	fishing industry
geothermal electricity generation industry	hydro-electricity generation industry
international and government funding agencies	insurance industry
manufacturing industry	meat processing industry
minerals exploration and development industry	museums and art dealers
oil and gas exploration companies	regional authorities and councils
research industry	transport industry
universities	water distribution companies

Active Landscapes

The active landscape section provides consultancy and research for better understanding New Zealand's dynamic landscape by determining rates of natural and human-induced change. The section also contributes to effective hazard management and sustainable land management. The section includes scientists with expertise in geodesy, paleoseismicity, engineering geology, geomorphology, and sustainable land management.

Earthquakes

Staff in the Earthquakes section have expertise in seismology, engineering seismology, seismic hazard and risk assessment, and recording and analysing earthquake motions including the response of buildings and other large structures such as dams. The section operates the national seismograph network that records an average of 15,000 earthquakes in and around New Zealand each year. It also operates the national accelerograph network which produces information that helps to make buildings and structures more resistant to earthquake-shaking. The section's scientists are recognised internationally for their research and consulting work.

Geological Time

The Geological Time section is New Zealand's centre of excellence in paleontological and paleoenvironmental research, which is integrated with the Institute's geomagnetic and geochronology programmes. This section services the petroleum exploration industry, particularly in New Zealand and Southeast Asia, and assists many universities and research organisations around the world. The section also maintains New Zealand's national paleontology collection and the New Zealand fossil database.

Geothermal & Minerals

The Geothermal and Minerals section promotes improved operational efficiency, increased exploration success, and better management of New Zealand's geothermal energy and mineral resources. The section's stable isotope team is skilled in the use of mass spectrometric analysis of mineral, geothermal, groundwater, hydrocarbon, and biological samples.

Groundwater

The Groundwater section provides the New Zealand and international groundwater industries with information to understand and sustainably manage groundwater resources. The section includes geologists, hydrologists, modellers, chemists, isotope scientists, and geophysicists. Facilities include an isotope laboratory for dating groundwater and a water/gas chemistry lab used for groundwater quality measurement and geothermal field analysis.

Hydrocarbons

The Hydrocarbons section assists petroleum exploration companies in New Zealand and the Pacific Rim through its studies on the origins, migration, and entrapment of hydrocarbons. The section's research is also aimed at increasing the understanding of the structural evolution of New Zealand and surrounding oceans. Increasingly, the section is applying its skill to problem-solving in natural resources. It uses expertise in seismic methods and acoustic physics to develop new approaches to assessing commercial fish stocks.

Isotope Applications

The Isotope Applications section provides customised services to primary and manufacturing industries by developing systems for product, process and waste control. It also provides an international consultancy measuring the isotopes carbon-14 and beryllium-10 to provide age dating for archaeology, anthropology, earth and environmental sciences. Other services include measuring the elements in environmental and industrial samples.

Mapping

The Mapping section focuses on regional geology, basement petrology, and the collection, analysis and presentation of geospatial information. The section specialises in application of geographic information systems (GIS) and produces digital maps covering areas of high scientific, economic and developmental interest, including New Zealand's population centres, coalfields, and resource prospects. The section's clients include planners, developers, oil, geothermal and mining industries, and science and education workers.

Volcanoes

Volcanoes section staff study the process, products, and frequency of volcanic activity in New Zealand. A particular focus is gaining a better understanding of the structure of the Taupo Volcanic Zone, which extends from Mt Ruapehu to White Island. The section's volcano surveillance programme evaluates the state of activity and the hazard potential of the North Island's volcanoes. This is particularly useful for civil defence organisations and for clients in the primary, tourism, aviation, and transport sectors as well as local authorities, and the hydro-electricity generation and insurance industries.

Visit our website for more information on our wide range of services and products.

<http://www.gns.cri.nz>

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The following articles on GNS' marine activities are from the most recent edition of Globe, the GNS newsletter, which Ms. Susannah Sharpe, Strategic Analyst of the institute, kindly sent to the editor for inclusion in our newsletter.

GNS Marine Activities

There are still vast unexplored realms in the depths of the oceans. It is clear that this untapped resource is bristling with a potential technological and medical harvest that will change our lives. That is why some commentators predict that investment in this area of science will produce a huge payback, especially for an island nation such as New Zealand.

Currently we know more about the surface of the moon than we do about the bottom of the ocean. GNS' marine activities are aimed at reducing that knowledge gap. GNS has always recognised that New Zealand is much more than the land currently above the ocean. Our marine activities have contributed enormously to the understanding of how the earth works.

In the not too distant future, New Zealand scientists will routinely explore the bottom of the ocean in submersibles. In this brave new world they will see deep ravines, vast plateaus, and active volcanoes. They will also discover a huge range of habitats - more numerous than terrestrial habitats.

Offshore studies have already led to significant improvement in the understanding of the structure and evolution of the New Zealand region. This contributes to more informed evaluation, development, and management of marine resources. With our partners, GNS will continue to play a vital role in acquisition and interpretation of marine information. This will help resolve some of the important scientific questions of our age and lead to a new wave of knowledge-led innovation.

Seabed energy source

Institute scientists are studying frozen seafloor deposits that could become an important energy resource in the 21st century. It is New Zealand's first systematic evaluation of the sea floor phenomenon known as gas hydrates - an ice-like material made of methane and water found in ocean sediments worldwide.

Hydrate deposits found mainly in the top 500m of the seafloor at higher latitudes, are particularly prominent off the North Island's east coast between Gisborne and Cook Strait, and off Fiordland.

Some scientists estimate that worldwide, gas hydrates could hold twice the energy of all known reserves of oil, coal and natural gas. The potential of hydrates can be illustrated by the fact that they are in a concentrated form and the gas expands to 160 times its volume when they are brought to the surface. The hydrates are potentially a multi-billion dollar resource, but technological restraints associated with their volatility and depth inhibit their development. Even small changes in seafloor temperature and pressure cause hydrates to break down and the methane to be released as gas. This weakens seafloor sediment, causing sudden slumping, and possibly triggering tsunamis. The methane released into the atmosphere is thought to contribute to green house warming.

Geophysicist Stuart Henrys is part way through a two-year study aimed at better understanding the distribution and physical properties of gas hydrates, the origin of the methane, and ways that individual components of gas hydrates change over time.

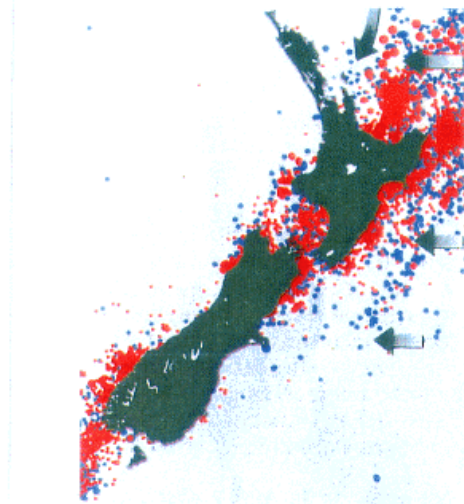
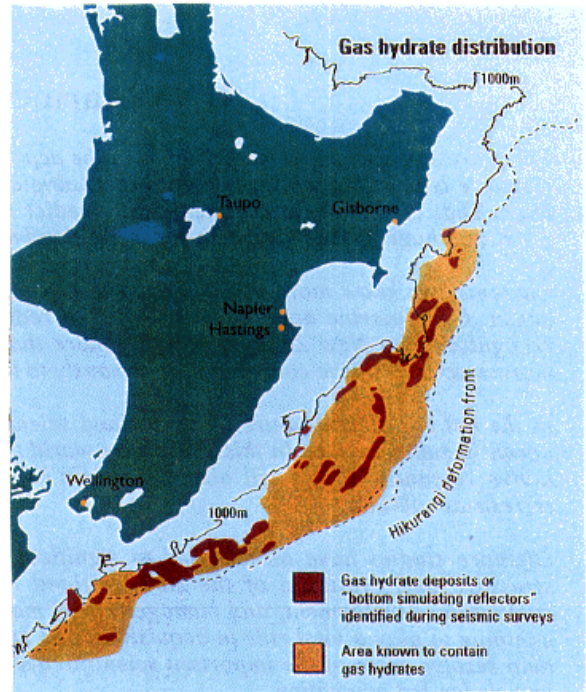
"Once we have a sound understanding of gas hydrates, we can work on resource characterisation - finding out how much is out there and locating the richest deposits."

Dr Henrys' team is using a combination of geological, geophysical and geochemical techniques to characterise gas hydrates. The work fits in well with GNS' other marine activities which



include evaluating oil and gas reservoirs, mapping geological structures on New Zealand's continental margin and assessing mineral potential of the seafloor.

The first serious attempt to drill and extract gas hydrates was made recently by a consortium of Japanese oil companies and the Canadian Geological Survey.

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Tsunamis can potentially originate from:

-  North & South American earthquakes
-  Local offshore earthquakes
Depth 0-14km (1990-94 data)
-  Depth 15-30km (1990-94 data)

Regional frequency of shallow offshore earthquakes indicates relative susceptibility of coastal areas to local tsunamis (See 'Tsunami and crustal structure').

Marine geology and geophysics

Seafloor off Fiordland revealed

The complex geology of the seafloor off Fiordland is a product of the Alpine Fault's transformation from a strike-slip fault (on land), to a subduction trench.

For years scientists have wondered what happens to the Alpine Fault where it leaves the South Island and heads into the Southern Ocean. A new map (next page), compiled by the Institute, provides the answers.

GNS scientists worked with Geosciences Azur, a consortium of French research organisations, to produce the map. Sophisticated multibeam echo sounding equipment on the French research ship *l'Atalante* was used to map the geomorphology of the seafloor. GNS scientists used geographic information system software (GIS) to integrate these data with information collected by the New Zealand Navy's Hydrographic Office. Deep seismic profiling equipment on the United States research ship *Ewing* was used to image rocks to a depth of 12km beneath the seabed.

The map has enabled scientists to identify active seafloor structures, such as faults, and explain their origins. It has added significantly to the body of geological and geophysical knowledge, and will be useful for hazard assessment, education, fisheries management, defence and evaluating offshore resources.

Where the Alpine Fault goes offshore at Milford Sound it splits into several faults that form major structures on the continental shelf. The branches of the fault transfer the plate motion between the onshore portion of the Alpine Fault and the plate margin to the south along the Puysegur Trench.

The rocks offshore from Fiordland originated far to the south, near the southern tip of the Campbell Plateau. "Over the last 40 million years they split away from the Campbell Plateau and travelled hundreds of kilometres, first west, then north, and finally northeast," says geophysicist and one of the map's authors Ray Wood.

A feature that fascinates scientists is the large "collapse" structure southwest of Fiordland, covering an area of about 1500km². It is probably the scar resulting from the collision of a seamount with the subduction trench as the two tectonic plates collided. Scientists estimate that, in its prime, the seamount may have been 50km long, 20km wide, and more than 2km above the surrounding seafloor.

Contact: Rick Herzer or Ray Wood

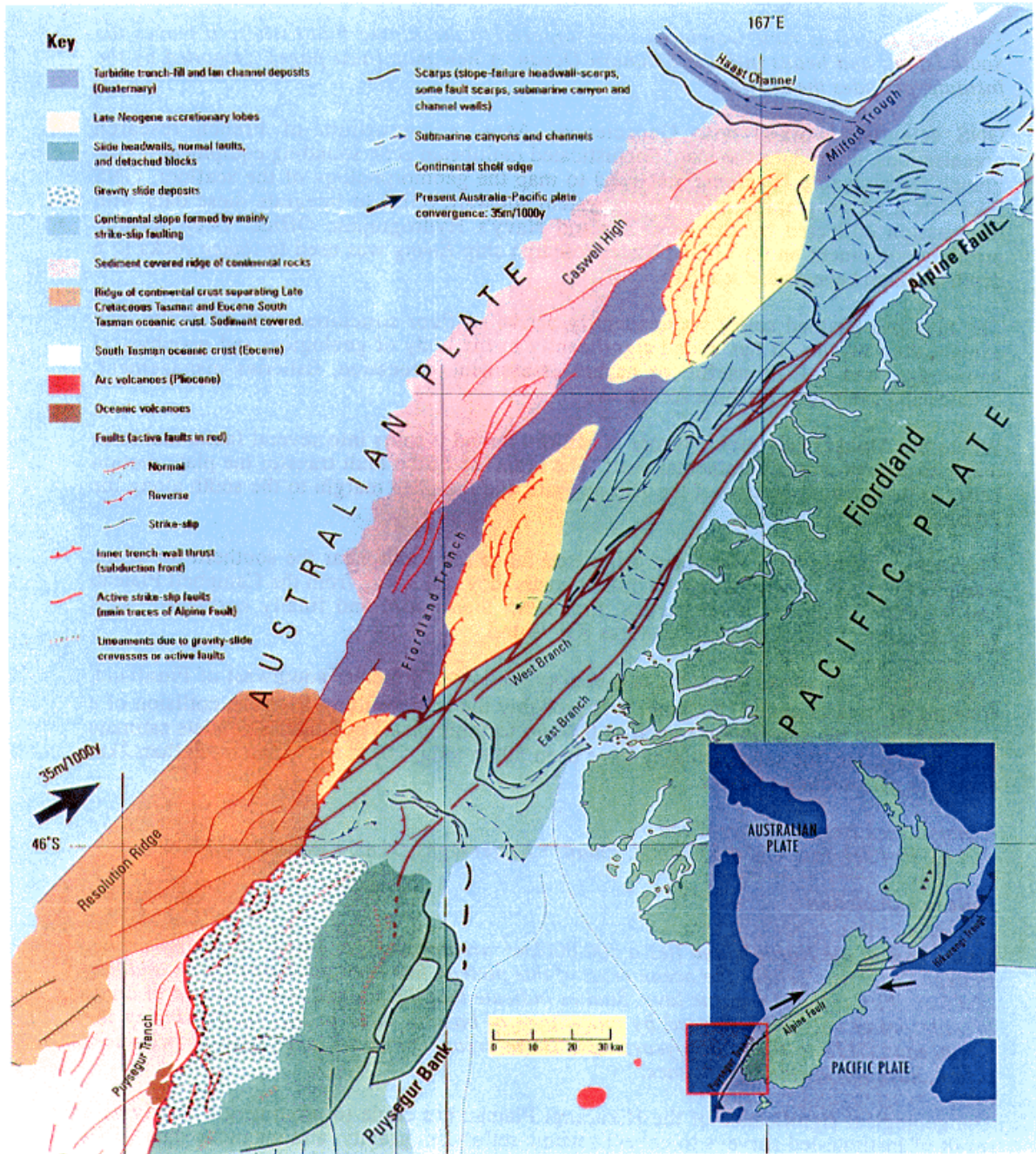
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Plateau subduction

To the east of the North Island lies a 300,000km² area of seafloor known as the Hikurangi Plateau. Scientists believe the ocean crust of this plateau has been thickened by the addition of a 5km-thick layer of basaltic lava. Studies indicate that the plateau is one of several areas of widespread volcanism formed by upwellings of basaltic lava in the Pacific during the Cretaceous - 135 to 65 million years ago. These areas, known as large igneous provinces (LIPs), have worldwide significance.

The geological significance of the Hikurangi Plateau has come to prominence mainly as a result of Institute-led surveys to collect seismic reflection, gravity, and magnetic data. GNS scientists have been working with international collaborators to clarify the exact mechanism of the plateau's formation.

The complex geology of the seafloor off Fiordland is a product of the Alpine Fault's transformation from a strike-slip fault (on land) to a subduction trench.

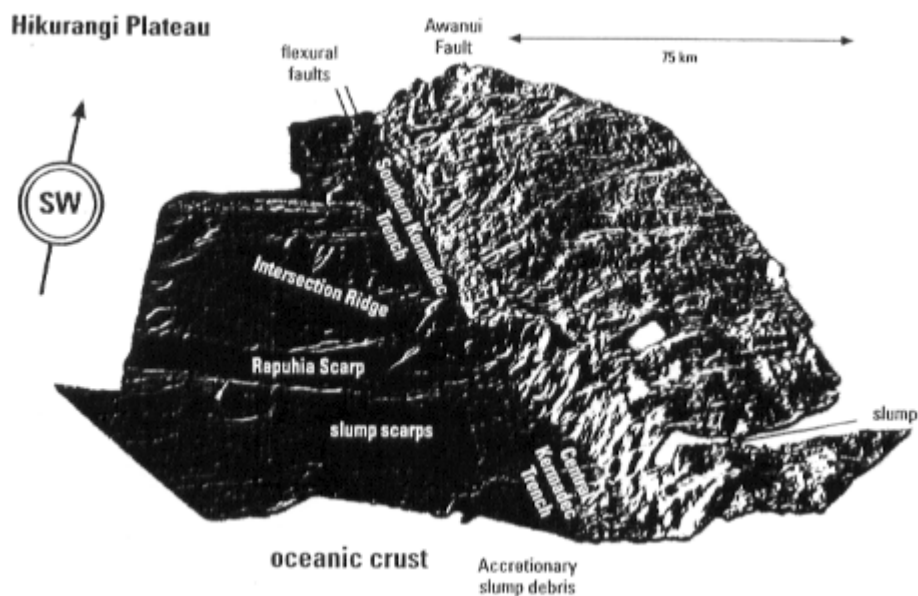


Recently in collaboration with French and United States organisations, and with New Zealand's National Institute of Water and Atmospheric Research, and principally using a French research ship *l'Atalante*, scientists collected detailed swath bathymetric data that has highlighted details of seafloor geological structures.

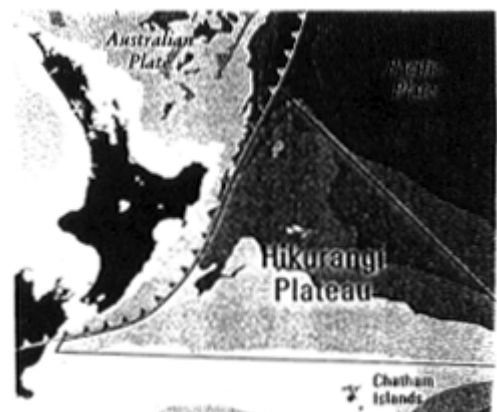
The subduction of such a large elevated plateau under the North Island is globally unusual and the main reason for the international interest. The plateau is more than double the thickness of normal oceanic crust. It is also buoyant because its high lava content makes it less dense than the underlying mantle rocks. As it subducts, it uplifts and deforms the North Island much more than normal oceanic crust would.

The subduction geometry determines which parts of the North Island are uplifted, thinned, thickened, rifted apart, and where volcanism occurs. The plateau is peppered with a large number of seamounts - huge extinct undersea volcanoes. Understanding this "roughness" as it scrapes beneath the North Island is important in understanding the generation of earthquakes.

Rocks, sediment, and fluids carried beneath the North Island on the Hikurangi Plateau comprise much of the raw material that is recycled during volcanism. Knowing more about the nature and volume of this material helps us understand volcanism and the geothermal and mineral products formed by that volcanic activity.



Seafloor perspective: View of the central-southern Kermadec Trench from the northeast. The image is derived from swath bathymetry collected from the French research ship *L'Atalante*. The 1km-high Rapuhia Scarp marks the northern boundary of the Hikurangi Plateau with normal (6km-deep) oceanic crust in the foreground (north). The 4-5km-deep plateau was subducting further north in the past and the western inner trench wall is collapsing following removal of the buoyant subducting plateau. Water depths in this image vary between 3km and 8km.



Unravelling the geological history of the Hikurangi Plateau is helping scientists understand the formation and subduction of LIPs worldwide. These huge volcanic areas are of more than just geological interest; during their formation they were a major source of heat on the Earth's surface. Such large eruptive episodes may have triggered global climate change during periods of the Earth's history.

The study of the continuing subduction of the Hikurangi Plateau under New Zealand will also help explain the dramatic deformation that accompanies any previously unrecognised LIP subduction episodes at other plate boundaries worldwide.

Establishing the Hikurangi Plateau as a natural prolongation of the New Zealand landmass, and determining its outer structural limits, are crucial to New Zealand's claim under the United Nations Convention on the Law of the Sea. New Zealand has until 2006 to lodge a claim that could extend its exclusive economic zone by more than 50 percent. This would give New Zealand jurisdiction over six million square kilometres of ocean floor, or one percent of the Earth's surface. New Zealand's EEZ covers about four million square kilometres and is currently the fourth largest in the world.

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Marine investigations in Antarctica

Institute scientists have worked on marine investigations, mostly seismic surveys, of the Ross Sea for the past three decades. The Ross Sea has been a particular focus for scientific studies because it corresponds to a major rift boundary between the Ross and Weddell seas which separates east and west Antarctica.

Early work by the Institute and its international collaborators identified the four major sedimentary basins forming the Ross Sea continental shelf. Antarctica has no onland rocks aged between 30 and 180 million years, so these marine studies provide a valuable record of the geological events of this period.

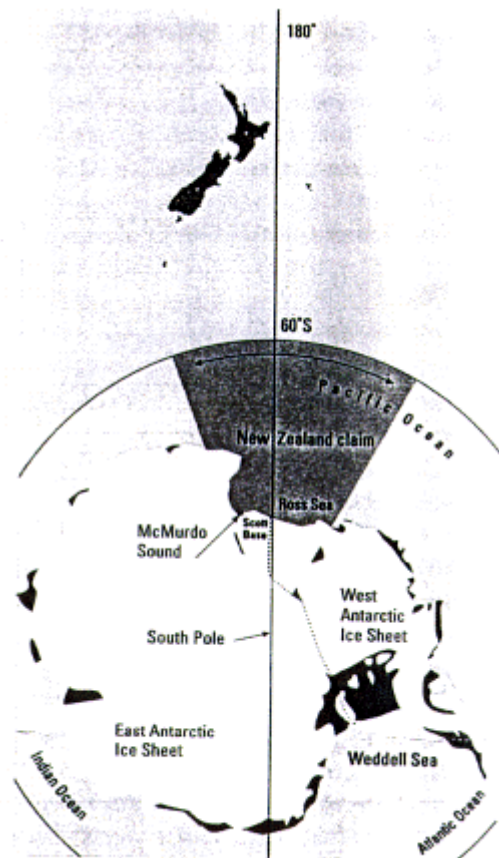
These studies have given scientists information on the breakup of the Gondwana supercontinent and the formation of New Zealand about 85 million years ago. Analysis of data from the Ross Sea provided information on movement of ice sheets and on climate changes during this period.

Seismic data have also provided targets for offshore geological drilling. Institute scientists and their collaborators have defined the targets in three multinational projects in Antarctica:

- the International Deep Sea Drilling Project in eastern and central Ross Sea in 1973
- the present multinational Cape Roberts Project in western McMurdo Sound
- the Ocean Drilling Project proposal for drilling in eastern Ross Sea.

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Offshore minerals and petroleum

Offshore hydrothermal & mineral investigations

In March 1999 a New Zealand-American scientific expedition found clear evidence of hydrothermal activity at five submarine volcanoes northeast of the Bay of Plenty.

The two-week study from the research ship *Tangaroa* revealed that half the volcanoes in a 400km-long stretch of seafloor have associated hydrothermal plumes. The study was a collaboration involving the Institute and the Seattle-based Pacific Marine Environmental Laboratory, a division of the National Ocean and Atmospheric Administration (NOAA), and the National Institute of Water and Atmospheric Research.

The study team discovered the volcanoes spewing out mineral-rich smoke plumes from seafloor hydrothermal vents, commonly known as black smokers. To find the plumes, the scientists trailed 300kg of sophisticated instruments in a metal frame behind the ship. When the instruments registered a plume, the ship stopped to allow detailed analysis, including plume temperature, density and flow direction. The plumes were found to contain high concentrations of iron and manganese, plus localised pockets of hydrogen sulphide. Laboratory analysis has confirmed the presence of other elements, such as copper and zinc.

Hydrothermal plumes occur where metal-rich, high-temperature fluids discharge from a seafloor vent. Before the fluid enters the ocean, it is commonly between 300 and 370 degrees Celsius and under high pressure. Under these conditions, it dissolves minerals in the surrounding rock like hot tea dissolves sugar. As the fluid enters the frigid ocean, the metals in solution precipitate out as fine-grained particles, producing an effect like smoke. Fine particles from the plumes fall to the ocean floor, sometimes building "chimneys" packed with minerals. These deposits are typically 1000 to 10,000 times more concentrated than background levels.

The most active and productive of the volcanoes is Brothers, 400km northeast of White Island. A portion of the Brothers plume, which originates from a vent near the bottom of the volcanic crater, is unable to rise above the crater walls and remains trapped in the caldera. Another vent, near the rim of the Brothers crater, pumps large volumes of mineral-rich fluids into the ocean.

Initial results show that the chemistry varies strongly between the volcanoes. But the unifying factor is that they appear to play an important role in supplying key elements such as iron, manganese and sulphur into the ocean. These elements are vital ingredients in the marine food chain.

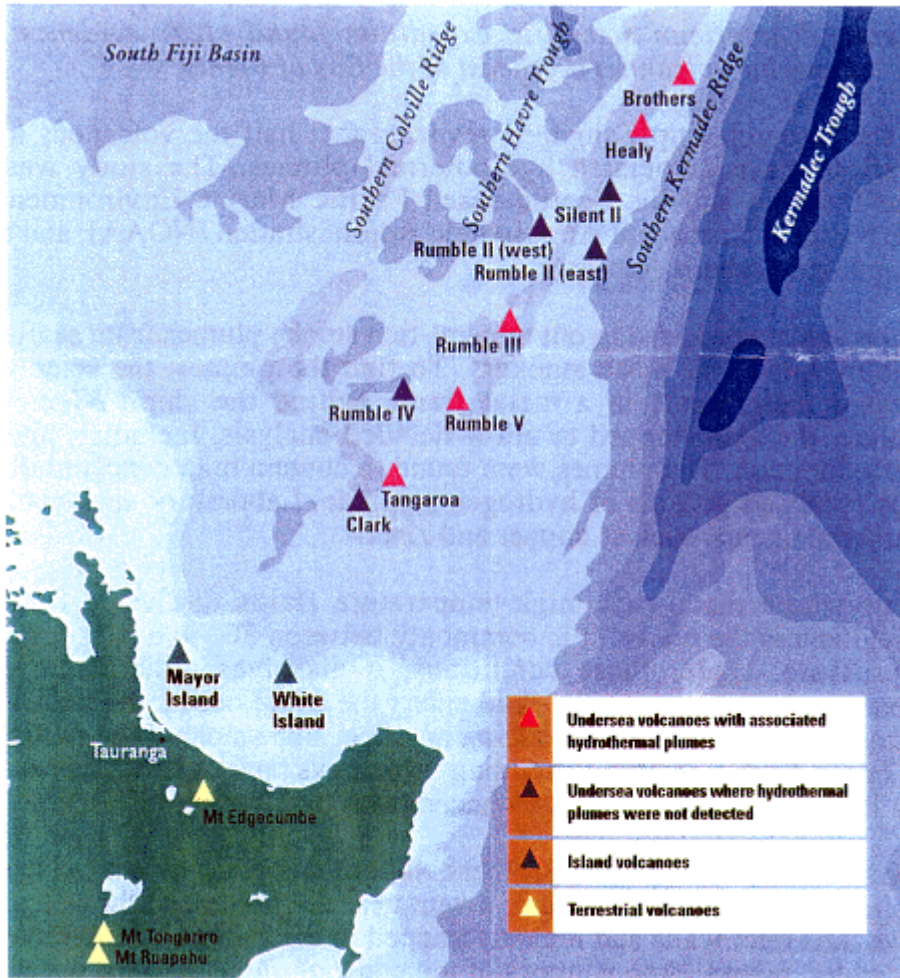
Above one of the volcanoes the American scientists on board found levels of hydrogen sulphide 10 times higher than they have seen in 15 years of studying plumes.

The plumes can rise 200m to 300m above a vent, and are eventually mixed into the ocean by currents. Hydrothermal plumes from chains of undersea volcanoes are thought to account for 15 percent of the heat in the world's oceans and an unknown, but significant, proportion of the mineral and nutrient content of seawater.

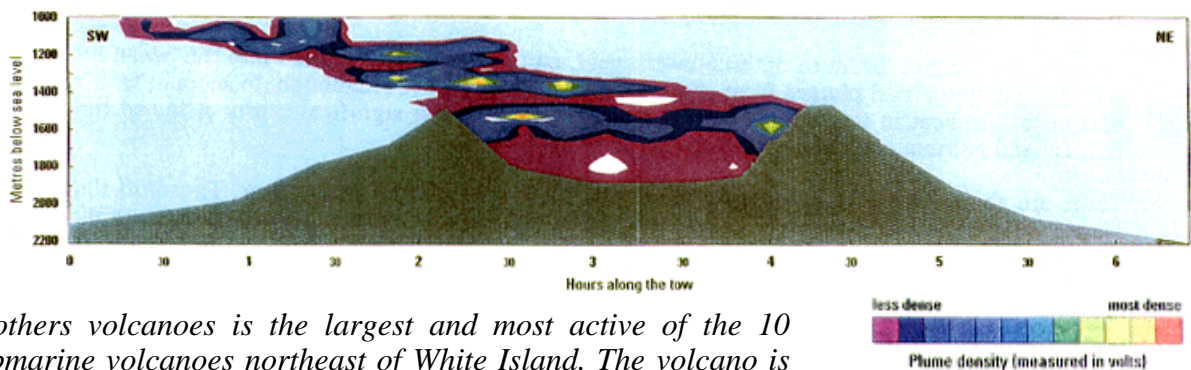
There are about 25 places worldwide where black smokers are known to occur. Those off the New Zealand coast are unusual because of their relatively shallow depth. Most others are on mid-ocean ridges at depths between 2.5km and 3km. The shallowest volcano in the chain off Bay of Plenty is at 120m and the deepest is 1800m.

Before this expedition only one of the volcanoes, Brothers, was known to include a black smoker. Because the most active seafloor venting occurs at the northern end of the study area, it is possible that hydrothermal activity and associated seafloor mineral deposits could occur all the way to Tonga.

The undersea volcanoes in the study area are among the most active active seafloor volcanoes of the world.



Brothers volcano hydrothermal plume density



Brothers volcano is the largest and most active of the 10 submarine volcanoes northeast of White Island. The volcano is 10km in diameter and its caldera is 3km in diameter. This graphic, obtained by towing a sophisticated instrument package across the volcano, shows the largest plume drifting southwest.

In 1996 the *Tangaroa* dredged up fist-sized samples from a chimney in this chain of volcanoes. The samples contained 18 percent zinc (by weight), 15 percent copper, and six parts per million gold.

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Petroleum research

Over the past 20 years, the Institute has produced comprehensive scientific reports on New Zealand's sedimentary basins. The aims of this project, called the Cretaceous-Cenozoic Project, are to investigate New Zealand's sedimentary geology to a uniform standard; provide a high quality database for hydrocarbon and mineral exploration; and identify onshore and offshore resources that need further investigation.

Each published volume, or monograph, makes a major contribution to understanding the geology of the basin concerned and provides key information to help explorers pinpoint likely hydrocarbon areas. Topics in each volume include surface geology, subsurface structures, neotectonics, basement rocks, and tectonic evolution. Hydrocarbon and source rock geochemistry, modelling of hydrocarbon generation, and prospectivity are also covered.

The Great South Basin is the third largest and least explored of New Zealand's sedimentary basins. All 100,000km² is offshore, although some of its geology is accessible along the Otago coast. Hydrocarbon potential of the Great South Basin is thought to be considerable, but the reserves are in deep water in an area of chronically hostile weather. The Institute is scheduled to release a major publication on this basin later this year. It will be the eighth and final monograph in the Institute's sedimentary basin series.

Exploration of the Great South Basin has involved drilling eight exploration wells and shooting 34,000km of seismic line. GNS scientists have reinterpreted the seismic data and determined new ages for the oil source rocks, which has helped give a better fix on the basin's petroleum potential.

Perhaps the most valuable outcomes from the Institute's study are a better understanding of the geochemistry of oils and source rocks, and of the basin's thermal history. This has improved the knowledge of the petroleum systems and enabled scientists to model the maturation and generation of hydrocarbons. The integration of source rock geochemistry, subsurface mapping, and basin history greatly enhances the understanding of the region's petroleum prospectivity.

The main outputs from the Institute's four-year study of the area are a monograph and an atlas set of 1:500,000 maps, nine seismic horizon maps and 15 derivative isopach maps, plus a set of paleogeographic maps at eight key levels. The maps give important new understanding of the region's geological evolution.

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Recent sedimentary research includes:

New Zealand reconstruction: Petroleum geologist Peter King has produced a series of maps showing paleogeographic and tectonic development of the New Zealand region through time. The animated maps are on display at Auckland Museum.

Browne's work on the sedimentological relationships in deep-water slope canyon systems in Taranaki has revealed that inland exposures show many interesting relationships, some of which were not recognised before. These canyons are cut during periods of lowered sea level, and have many factors that make them conducive as reservoirs. This work is helping petroleum exploration companies gain a better understanding of prospectivity in the Taranaki Basin.

Sediment cores:

Sedimentologist Tim Naish is planning to take two deep drill cores from the Wanganui region to provide a detailed sedimentological record of the basin over the past three million years. Collaborating in the project are researchers from Australia and Germany. The end result will be the development of a detailed stratigraphic sequence related to sea level changes over the past three million years.

Outcrop studies:

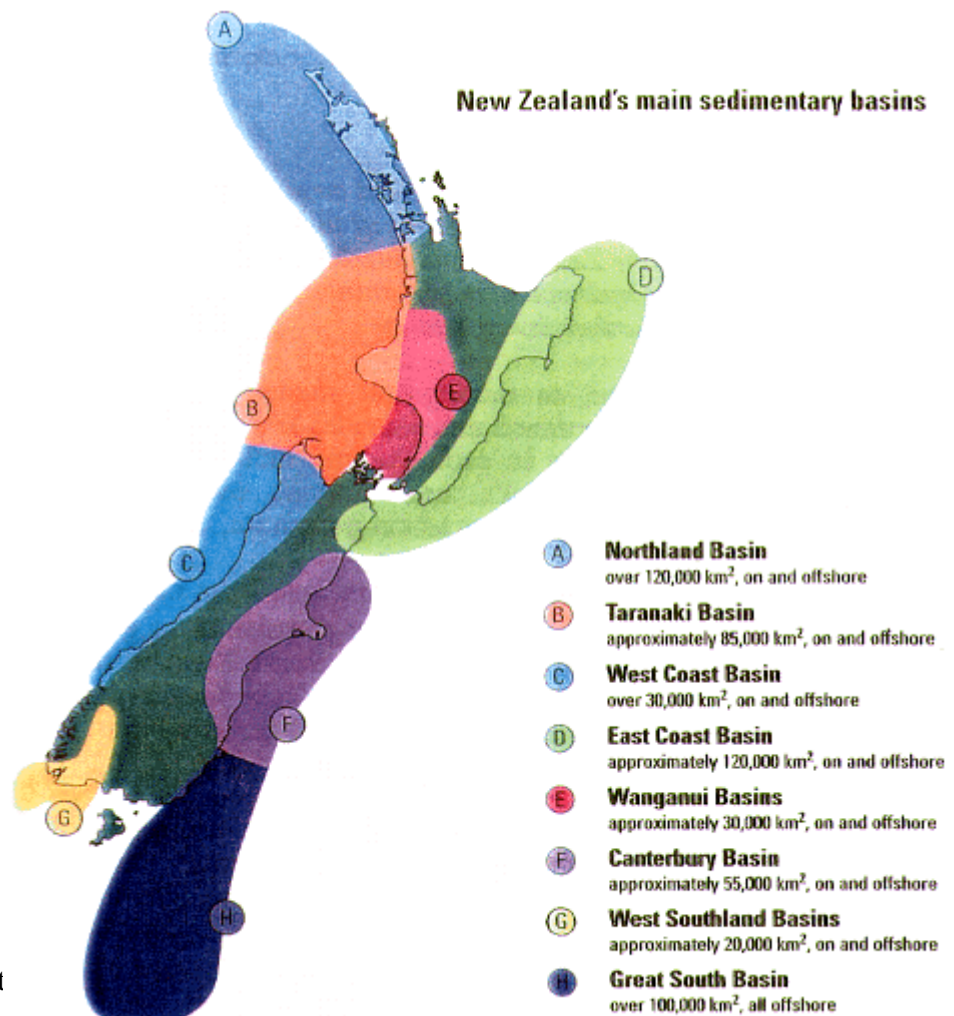
Petroleum geologist

Greg Browne's outcrop and sub-surface studies at

Mt Messenger in Taranaki have improved the understanding of factors that control the distribution and lateral extent of petroleum reservoir sand bodies. These studies are relevant to other areas, both in New Zealand and internationally, where slope fan sand systems are important reservoirs.

Thermal modelling: A new thermal modelling technique developed by GNS scientists has enhanced the accuracy of mapping the location and timing of oil and gas generation. The technique is particularly useful for understanding the formation and maturation of complex tectonic basins such as Taranaki and East Coast that have undergone several phases of deformation, uplift, and deposition. Petroleum exploration companies have used the technique to improve the tracking of migration paths of oil and gas from source to trap.

Quantitative biostratigraphy: Quantitative biostratigraphy is the name given to a relatively new group of computer and mathematical techniques that help exploration companies gain more accurate information from drill cores. The Institute is a leader in developing this family of techniques which improves precision in dating biological samples from wells.



Fisheries research

Listening to fish

The Institute recently formed a partnership with a North American company that has developed a broadband sonar system for finding and identifying fish. This technology is aimed at sustainable, cost-effective harvesting with minimum by-catch.

The system is based on the integration of military technology and neural networks. The broadband signal used by the system has energy in many different frequencies. Echoes from this signal contain much more information than those from existing technology that use one or, at most, a few frequencies. Recent trials have been successful in identifying the species of shallow-water fish more than 75 percent of the time, with similar results for identifying the size of fish.

Improving the accuracy of finding and identifying commercial fish stocks is expected to lead to a more environmentally-friendly management regime for New Zealand's fishery resources.

GNS has been using its expertise in signal processing to improve the performance of the North American system, particularly in identifying species and size in mixed schools. The aim is to gain more accurate information about the numbers and size distribution of each species.

The system is currently being modified to survey New Zealand's deep-water and mid-depth species, such as orange roughy and hoki.

Seismologists and oil exploration companies have long used techniques similar to acoustic echo sounders to examine rocks under the Earth's surface. The Institute has strongly-developed capabilities in analysing signals from broadband sources such as earthquakes and explosives and the move into fishery acoustics is a simple extension of this capability. GNS scientists have developed extraordinarily sensitive and cost-effective technologies to detect weak echoes from oil-bearing deposits many kilometres under the Earth's surface.

Trials with broadband equipment have been underpinned by modelling of the acoustic signal reflected by deep-water fish. The modelling is being used to predict the reflected signal from single fish, single-species schools of fish, and mixed-species schools.

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Reading the strontium code

Finding out the individual life histories of commercial fish species is becoming increasingly important in fisheries management.

GNS researchers have refined a technique that translates the chemical code that represents the life history of the fish in the otolith - a structure in the inner ear of fish.

The technique is based on strontium, a benign element that occurs naturally in sea water and is closely related chemically to calcium. It is laid down continuously throughout the life of a fish in inner-ear calcium carbonate structures called otoliths. Strontium becomes a permanent part of the otolith which grows slowly and steadily over the life of the fish.

The rate of strontium deposition in the otolith depends on both ambient water temperature, and on the acidity, or alkalinity, of the endolymph - the fluid of the inner ear in which the otolith grows. The pattern of strontium distribution in the otolith provides a code summarising the combined effects of ambient water temperatures and the changes in the metabolic activity of the fish during its life.

Using the Institute's Van de Graaff accelerator and a technique called proton-induced x-ray emission, scientists can produce a visual display of the distribution of strontium in the otolith. This enables individual fish to be sorted into groups with different life histories. In essence, the information tells scientists about the water masses through which fish have passed during their life, and indicates the rates of metabolic activity at various stages during their life.

The otolith strontium code allows fisheries managers to trace patterns of movement of fish that have lived similar lifestyles. For example, it may help provide answers for the recent appearance of Peruvian jack mackerel in New Zealand waters. Until the early 90s the species was seldom caught outside South American waters. Scientists are still unsure why the fish started appearing in ever-increasing numbers in New Zealand waters eight years ago.

Traditional methods of grouping fish based on genetic similarities or on body features have been largely unsatisfactory because there is more variation among a single population at different times than there is between different populations. Tagging also has disadvantages. As well as high cost, scientists don't know how much the stress of being tagged affects fish behaviour. Decoding the strontium record exploits the inherent variability in populations rather than trying to remove that variability by searching for distinct "biological brands" to try to distinguish different groups of fish within the same species.

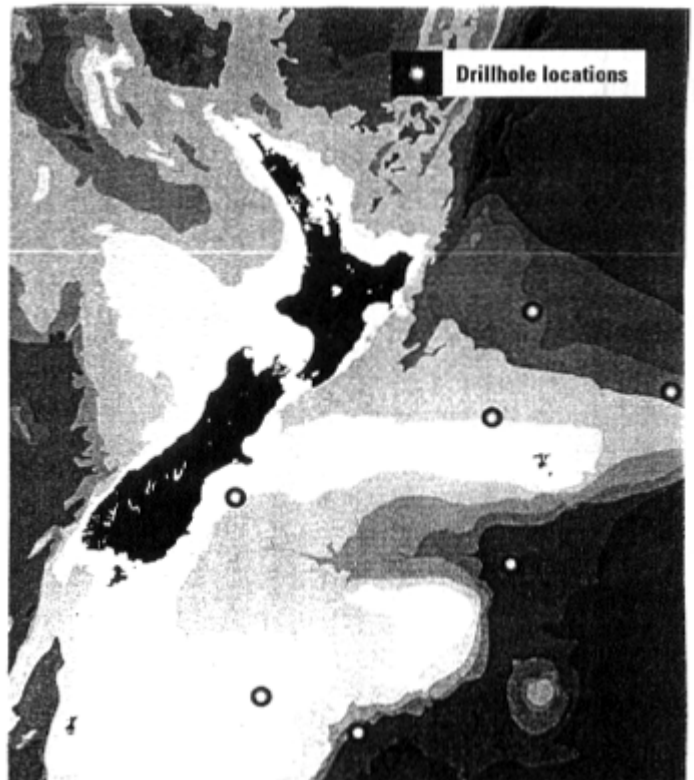
Use of the strontium code will enable seafood companies to prove that a fish or fish product came from a particular bay or stretch of ocean. This will enable them to develop an appellation - a brand that identifies with a region. Well marketed appellations attract premium prices.

The Institute is one of the few organisations capable of performing this type of x-ray analysis to a level that produces consistent and meaningful results.

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Probing ocean depths not only provides a window into the future but gives us fresh insights into the way the Earth works.(See 'Ocean Drilling Programme').



Ocean Drilling Programme

Undersea sediments key to geological past

The Institute is taking part in an international study to probe the secrets of the ocean floor off the east coast of New Zealand. The study is part of the Ocean Drilling Programme (ODP) - a decades-long exploration of the world's ocean basins.

The world's most advanced research ship *Joides Resolution*, came to New Zealand in late 1998 largely as a result of the vision and hard work of the National Institute of Water and Atmospheric Research.

Joides Resolution drilled cores at seven locations in the Pacific and Southern oceans at depths ranging from 400m to 4500m. Cores were brought to the surface in 10m lengths, and sliced in two lengthwise for on-board scientists to study.

The Institute's Gary Wilson, who specialises in studying magnetic fields in ancient rocks and sediment, was one of three New Zealand scientists on the expedition. Other Institute scientists are contributing studies of tephra chronology and microfossils to the expedition's science report, scheduled to be published in 2001.

The expedition's most interesting drill hole, from a global perspective, was 450km northeast of the Chatham Islands. It contained a full record of all the times the Earth's magnetic field has switched over the past 20 million years.

From a New Zealand perspective, the most interesting hole was drilled in 4500m of water 600km east of Gisborne. The core contained 140 distinct volcanic ash layers from the past 12 million years and is the first complete record of the North Island's big volcanic eruptions over this period.

The ODP is an international scientific project aimed at unlocking the secrets of the Earth and the workings of the oceans. Funding comes from the eight ODP partners representing 21 countries. ODP has recovered deep cores from more than 1100 sites worldwide.

The seabed to the east of New Zealand is interesting because it lies across the path of a cold, dense Antarctic current that flows along the bottom of the ocean and surfaces in the North Pacific. This current carries millions of cubic metres of cold water every second equivalent to 100 times the flow of the Amazon River - making it an important component of global temperature transfer.

The layers of sediment beneath the current provide a detailed history of the composition, temperature, and strength of the current over the past 30 million years. The sediment layers also record other global and regional geological events during this period.

Detailed analysis of cores drilled during the recent expedition will continue for years. A refrigerated store in Texas holds more than 4km of core from the expedition, which is available to scientists from all over the world.

The Institute maintains the official Southern Hemisphere ODP microfossil reference collection.

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Tsunami and crustal structure

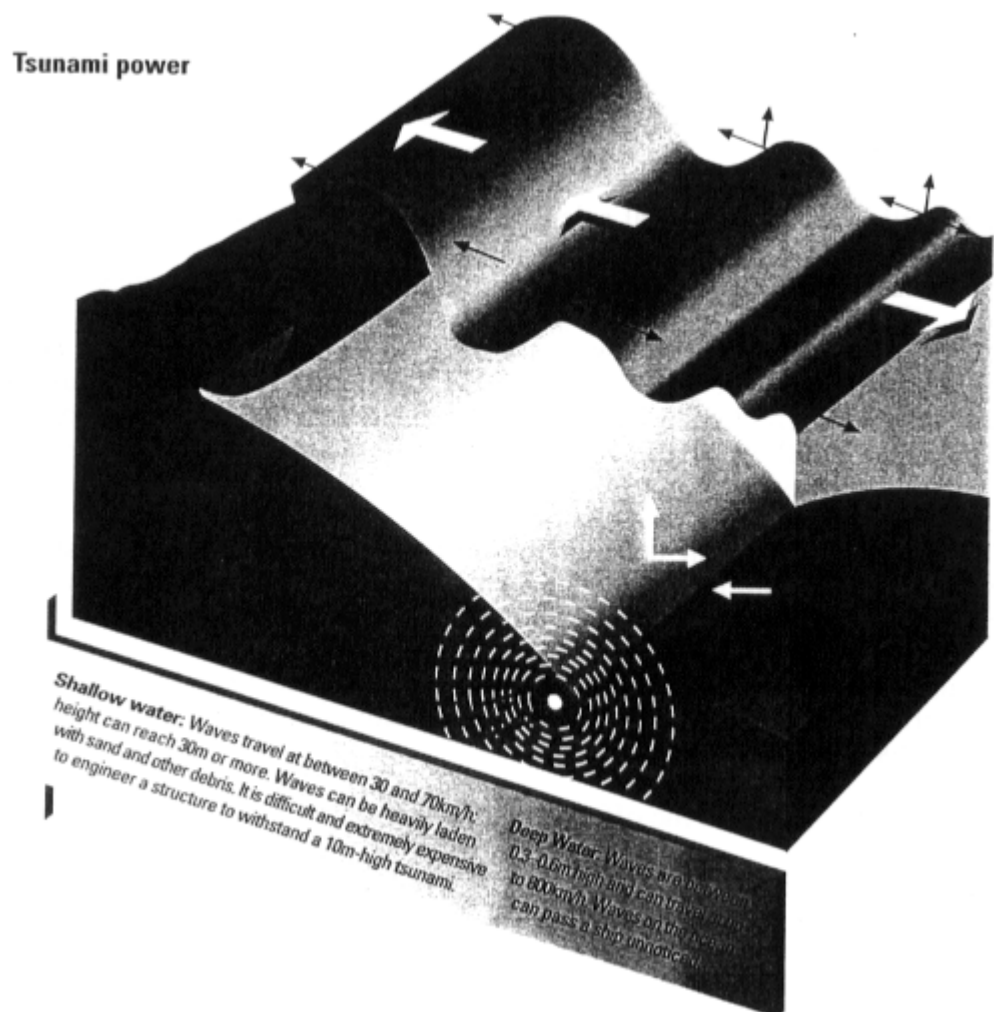
Not if, but when - New Zealand's tsunami hazard

New Zealand's position on a rapidly converging plate boundary makes its near-shore ocean regions a potentially important source of tsunamis. At least 100 tsunamis have hit New Zealand since European settlement, although only four or five have been large enough to cause significant damage. The more damaging tsunamis tend to be triggered by shallow earthquakes and landslides near the coast.

The Institute's tsunami research focuses on frequency, generation, and impact of local tsunamis. Recent collaborative research includes:

- a review of earthquake records and historical accounts of New Zealand tsunamis to better define source mechanisms
- studies of coastal wetland sediment at Abel Tasman National Park, and Wairoa in northern Hawke's Bay using sedimentology, radiocarbon dating, geochemistry, paleontology, and palynology to identify and date past tsunamis
- surveillance of the damage caused by the 1998 tsunami at Sassano Lagoon, Papua New Guinea. This devastating tsunami, which killed more than 2000 people and left many thousands homeless, occurred in a geological setting similar to the North Island's east coast.

This graphic depicts a subduction zone earthquake on the seafloor off New Zealand's east coast. As waves approach land, they slow down and increase in height. Sometimes the first indication is a sudden retreat of water from the shore. The biggest wave doesn't always arrive first. The second, third or fourth wave can be the biggest. Waves can continue arriving for some hours. The interval between waves can vary from seconds to hours.



Lessons learned from these studies have been used in coastal hazard assessments for regional and local government agencies. Wetland studies in Abel Tasman National Park at the top of the South Island have revealed that big tsunamis occurred about 1440AD and 1220AD, and two smaller tsunamis left their mark about 350AD and 1855AD. Only one of these, the 1855AD event, was recognised before the Institute's study. And at Kapiti Island, west of Wellington, studies have revealed that five 10m-high tsunamis have crashed into the island in the past 3500 years.

The Papua New Guinea study revealed the tsunami was up to 15m high and travelled at about 70km/h on land. The event underlined the immense power of tsunamis. Further along the coast away from the most severe damage, where the wave was just 3-5m high, forces were still enough to strip concrete from its reinforcing. Results of the study have helped with hazard planning and disaster management in New Zealand.

New Zealand's historical records are too short to answer questions such as which parts of New Zealand are most at risk from tsunamis, and how often damaging tsunamis occur. The Institute's research into these questions is supplemented by knowledge of active coastal and offshore faults and folds, and interpretation of sedimentary records of ancient tsunamis that have hit New Zealand.

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Understanding crustal structure and deformation

New Zealand and its offshore region lie across the boundary between the Pacific and Australian crustal plates. Relative movement between the two plates gives rise to earthquake and volcanic activity, the uplift of the Southern Alps in the South Island, and sedimentary basins where resources occur.

The Institute has made a major contribution to understanding these features, and the processes causing them, through marine crustal investigations. This involves studying the entire rock layer from seafloor sediments to structures tens of kilometres below the seafloor. The dominant tool for these investigations is seismic reflection profiling which gives detailed images of the rock layers up to 50km below the surface.

With New Zealand and international collaborators, GNS scientists have been using sophisticated marine seismic instruments from the oil exploration industry to collect high-quality data at a fraction of the cost of land surveys.

GNS scientists have completed several large-scale crustal seismic surveys focusing on the North Island's East Cape, Cook Strait, across the central South Island, and south of Stewart Island. Revelations from these investigations include:

- the major crustal downwarp under the Wanganui Basin and the overthrusting of these rocks over the Taranaki graben
- the crustal thickening under the Southern Alps and the downwarping of the western South Island as these rocks are thrust up along the Alpine Fault.

Results have defined how the crustal structure changes along the study profiles, how this relates to the deformation of the plate boundary zone, and how the deformation is caused and accommodated. This helps scientists understand New Zealand's natural hazards and contributes to the understanding of hydrocarbon and mineral resources.

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Sri Lanka GEOLOGICAL SURVEY & MINES BUREAU



The following article is an extract from the web page of the Geological Survey and Mines Bureau, <http://www.gsmb.slt.lk/>. The editor wishes to express his thanks to Dr. N.P. Wijayananda, Director of the Bureau for allowing him to use the information in the web page.

Introduction

The Geological Survey and Mines (GSMB), formed under the provision of Mines & Mineral Act (MMA #33) of 1992, and structured to commercialize the mineral sector in the country is the former Geological Survey Department.

The mission of the Bureau is to promote and manage the mineral resources of the country. It seeks to ensure that this mineral potential is realized for the benefit of Sri Lanka and that minerals area extracted in an efficient, safe and environmentally friendly manner. The Bureau provides expert advice to all concerned.

Origin of Organization

The newly established Geological Survey and Mines Bureau is the proud successor to a series of geo-scientific departments which span nearly a century, starting as the Mines Survey of Ceylon (MSC) in 1903 headed by Ananda Coomaraswamy. Throughout the history, these departments had an exceptional record of discovering, promoting and acquiring data on the country's mineral resources, to which all currently operating mineral-based industries owe their existence.

By 1939, the MSC was known as the Department of Mineralogy and in 1962 renamed again as the Geological Survey Department. On 18th March 1993 the Bureau was established through the Mines and Minerals Act #33 of 1992 to combine the functions of the Geological Survey with the new responsibilities of a modern Mines Department.

The establishment of the Bureau as the lead agency in mineral development underscores the Government's commitment to promoting mineral-based industries. Minerals, by providing substitutes for expensive imports; commodities for the building and construction industry and the raw materials for export industries, create employment and generate income for the country. The Bureau is also responsible for maintaining the national geo-science database, and ensuring that this information is made available to the public.

Organization of the Bureau

The Bureau has four primary operations: geological mapping and mineral exploration (core activities), mining titles and mining regulation; client responsive activities (mineral resources surveys, laboratory services, geophysical and drilling contracts); and geo-science information (access to published and unpublished reports, maps and other archives in its Library).

Services Available from the Bureau

- **Mining:** Administration of the Mines and Mineral Act #33 of 1992 and implementation of the Mining (Licensing) Regulations of 1993. The Act gives equal access and status to all qualified applicants on a first-come, first-considered basis. It established three principal mineral titles (for all minerals except hydrocarbons and gems): and Exploration License (EL), an Industrial Mining License (IML), and an Artisan Mining License (AML). It also issues transport, trading and export licenses. The Act gives attention to good practice in mining and quarrying, mine safety and miners' welfare. The Bureau is a gazetted Project Approving Agency (PAA) within the Environment Act, and is responsible for ensuring that mining activities are undertaken in an environmentally friendly way.
- **Mineral exploration:** Geological mapping and mineral investigations
- **Geophysics:** Mineral exploration and groundwater investigations by geophysical methods, using resistivity, hammer-seismic magnetometer and electromagnetic surveys
- **Core drilling:** A well equipped drilling section conducts drilling for engineering geological investigations and mineral exploration.

Important Events in Nearly a Century Services to the Nation

Raw Material for Industrial Development

- Limestone (Jaffna, Puttalam, Kankasanturai); clay (Murunkan) for cement
- Brick & Tile clay, ceramic clay, feldspar, vein quartz, calcite for ceramic products
- Mineral sands (ilmenite, rutile) for export (Pulmoddai)
- Apatite from the Eppawala phosphate deposit for fertilizer
- Mineral resource survey - North Western, Central and Southern Provinces of Sri Lanka

Geological Mapping of the Country

The whole country has been mapped at one inch to one mile scale (1:63360) scale; 74 filed manuscripts and 4 printed maps at 1:500,000 (Geology, Tectonics, Mineral resources, Metamorphic geology) are available. A new series of 1:100,000 full colour maps is being prepared using digital cartography, and will provide the geology for a national GIS. Seven sheets out of 21 have been published.

Future Programme

- Advising small-scale industries on raw materials
- Exploration for minerals for industrial development
- Large-scale geological mapping of the country
- Publishing geological maps and geological data

Further information may be available from:

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Sri Lankan Government has just announced the National Mineral Policy. The following article is the newly announced policy, which Dr. N. P. Wijayananda, Director General of the Geological Survey & Mines Bureau, kindly sent to the editor for inclusion in our newsletter.

MINISTRY OF INDUSTRIAL DEVELOPMENT
NATIONAL MINERAL POLICY - 1999
(Except Gems and Hydrocarbons)

1. Introduction

1.1 It is a truism that the physical needs of man are met by the products of two basic activities-agriculture and mining. An adequate supply of minerals is therefore essential for the maintenance and improvement of his standard of living. Mineral resources are, for all practical purposes, considered non-renewable. As a generalization, it may be said that the richer mineral deposits of the world have been, or are being, exhausted, and future needs must be met from larger deposits of progressively lower grade.

1.2 Minerals pervade our lives and determine our country's progress. We need minerals for industry, commerce, and for our pleasure and relaxation. The nonmetallic minerals of Sri Lanka as a group constitute the most important physical resource-base in terms of quantity and value. Also, in terms of its potential to sustain a long term socio-economic development.

2. Mineral Policy Objectives

2.1 The main objectives of the mineral policy include the strengthening of the minerals sector and to provide its institutions and other industrial support structure with the necessary know-how, tools and mechanisms to ensure an optimal utilization of the country's mineral resources, providing for the creation of new employment opportunities and maximum contribution of the sector to the national economy, through domestic value addition by product development, and its export trade, keeping in mind to give due consideration to the natural environment.

2.2 In this context an important overall objective will be to achieve an increased efficiency of all activities in the mineral sector by assigning appropriate roles to and establishing close co-operation among the institutions, organizations, associations and enterprises involved in and, particularly executing and coordinating these activities.

2.3 It is also envisaged that the sustainable development of the mineral sector would be undertaken on a strategic planned-basis compatible with land use policy objectives keeping in mind the scientific, national and user interest. The government shall facilitate exploration and mining and the usage of mineral commodities.

2.4 In respect of specific minerals the objective will be to plan and encourage their industrial utilization in a way which:

- increases diversification which includes not only increased mineral processing but also more mineral based manufacturing prior to export.

- allows the users and in the final analysis, the national economy to derive maximum benefit from this (non-renewable) resource base.

- attempts to obtain the best return from mineral exports when increased mineral processing and mineral based manufacturing are not feasible or desirable.

- reduces indiscriminate mining and export of raw materials without product development.

- provides maximum protection and optimum management of the mining environment, meaning both the natural habitat in which mining and beneficiation are carried out and the working environment of personnel.

- safeguards the long term raw material requirements of the present and future projected domestic mineral-based industries minimizing environmental damage.
- seeks better regional distribution of mineral activities taking into consideration the conservation for future use and stretched-out development where there is a possibility of depletion.
- uses an adequate supply of minerals whether from domestic or foreign sources to meet Sri Lanka's needs, while also maintaining the general goal of obtaining the best benefits for Sri Lanka from mined raw materials.

2.5 In respect of existing mineral based-industries the objective will be to support and consolidate their operation and management in a way which:

- improves their financial viability inter-alia through promotion of privatization and /or cost effective management practices.
- increases the value added component of products where appropriate.
- raises the level of awareness of and access to new or improved production technologies and practices.
- permits a larger share of the production to reach export markets through conscious selection of product mix and design and adherence to quality standards.
- promotes strong backward and forward linkages as well as linkages among the industries themselves.

2.6 In respect of new mineral processing industries the objective will be to create an industrial and scientific environment which:

- makes it attractive for new small scale entrepreneurs to establish themselves inter-alia through adequate access to technological, financial and managerial support.
- makes it attractive for foreign investors and/or technology holders to establish joint ventures with Sri Lankan partners without jeopardizing the interests of the national economy.
- gives priority to product groups or technologies in which the country holds comparative advantages due to availability of high quality domestic raw materials and/or a high degree of labour intensiveness in the production process.

3. Development Strategies

3.1 The development of the mineral sector of Sri Lanka to a level where it effectively can fulfil the important role assigned to it in the context of overall economic growth is a long range undertaking of considerable complexity. However the ultimate benefits are expected to justify the effort fully.

3.2 It is proposed to consider the development in four stages:

- restructuring and strengthening of the sector to provide an integrated competent and efficient institutional support structure allowing a self sustained growth of the mineral based industries.
- the Mines and Minerals Act No.33 of 1992 and the regulations framed under the Act also contains various aspects of the role of the government in minerals development. It is expected that the provisions of the Act and regulations will be reviewed periodically and harmonized with the relevant policies governing industrial activity.

- rehabilitation, strengthening and diversification of the existing industry with a view to increase its competitive edge, export potential and employment creation capacity.
- creation of new industries with a view to tapping so far dormant mineral resources or increasing the country's export earning.

3.3 Geological Survey & Mines Bureau (GSMB)

The GSMB is the principal institution charged with the function of all activities concerned with mineral resources development of the country and the administration of the Mines & Minerals Act. The National Aquatic Resources Research & Development Agency (NARA) is the organization concerned with Oceanography. Geological Mapping and Mineral Exploration would be undertaken as a continuous exercise and special attention would be given to maintain efficient supplies of mineral raw material to the existing industry.

3.4 A national inventory of mineral resources would be available and will be based on a review of exploration and other data. Geological maps would be up-dated and printed from time to time and publication of maps with explanations, memoirs and mineral bulletins will be made available periodically.

4. Development of the Mineral Sector

Exploration and Mining

4.1 Exploration concerns itself with the discovering of economic mineral deposits. After a deposit has been located and reserves proved as economic, mining must be considered. Local industry for the manufacture of mining equipment and machinery will be encouraged and steps will be taken to facilitate financing of mine development. Foreign participation in the development process will be encouraged in the form of joint ventures or other forms of contracts. Enhanced equity holdings over the government ceiling on foreign equity can also be considered on a case by case basis.

4.2 Small scale or artisanal mining with low consumption of capital will be accorded priority in the mineral development programmes of the government. The emphasis on small scale mining operations has the major objective of overcoming the prevalent high level of unemployment amongst the youth population. Common studies to introduce productivity techniques, norms and goals in the mining sector shall be undertaken and introduced from time to time.

4.3 Every effort would be made to increase the safety of workers in mines and reduce accidents, also to minimize the adverse impact of mining on the health of workers including the surrounding population. Mineral deposits being exhaustible, every mine when economical extraction is complete needs closure. Whenever mines closure becomes necessary such areas need rehabilitation in keeping with the mines and minerals law and the environmental law. However, it may be kept functioning not for production, but for educational and research purposes. If land acquisition is involved for mining purposes efforts shall be made to relocate and rehabilitate all persons affected by the acquisition.

Mineral Processing

4.4 Every effort would be made to strengthen the analytical capabilities of all institutions involved in research, development and processing activities of mineral raw materials. Close links amongst these institutions would be maintained.

4.5 As an important conservation measure re-cycling of mineral wastes shall be encouraged. Similarly the up-grading of low grade mineral raw materials, mineral wastes and rejects will be considered where possible.

4.6 Every effort shall be made to maintain efficient supplies of minerals to the operating industries and close links would be encouraged between the mineral supplying agencies and agencies of mineral based end products.

5. Conservation

5.1 The government shall improve mineral conservation and use to ensure efficient mineral supply for national needs. The mineral sector more than any other sector has to ensure that the environment and the resources it contains are managed and used both productively and conservatively. If it is deemed necessary the government may develop any mineral deposit for the realization of national goals.

5.2 Sri Lanka should not be complacent about the adequacy of its mineral resources. Long-range survival of Sri Lanka's mineral resources should be given serious consideration. This means that resources must not only be maintained but also expanded. Every endeavour would be made to prevent unsystematic or unscientific mining and conservation of resources will be encouraged through improvement in mining techniques, beneficiation and utilization of low grade ore and waste.

5.3 Mining and Mineral development would be maintained in such a manner as to ensure a sustainable development strategy of resources in harmony with the environment.

6. Export Policy

6.1 The export policy on minerals shall take into consideration that minerals are a nonrenewable resource and at some stage or other every mine is worked out or becomes too costly to operate. Export policy should therefore study the long term needs of the country and ban the export of minerals upon which the local industry has been based. Every effort shall therefore be made to export finished and value added mineral-based products.

6.2 Long term mineral adequacy is always subject to some uncertainty and problems associated with local depletion will occur from time to time. The government should therefore ensure efficient mineral supply for national needs and government support of the mineral industry will generate the best possible benefits. The imports of mineral-based material shall also be coordinated as far as possible with the development of indigenous mineral-based industries.

7. Fiscal Measures

7.1 All fiscal measures will be aimed at the overall development of the mineral sector and will promote mineral exploration, mining, beneficiation and wherever possible value addition in this sector.

7.2 The government will also seek increasing returns to the country from exportable mineral based products where possible. The government could obtain enhanced revenues from minerals through higher taxes, royalties, public equity participation or higher export prices.

7.3 Incentives to the mineral sector will be considered and at present it is substantial. However, mineral industry taxation will be under review from time to time.

7.4 It is reasonably certain that the mineral production in Sri Lanka has had a positive effect on economic development. Numerous industries have developed because of minerals and the benefits to the economy from investment to foster the mineral industry have been worthwhile.

8. Regulation of Mineral Resources

8.1 The management of mineral resources is the responsibility of the central government. With the enactment of the new Mines and Minerals Act No.33 of 1992 and its regulations No. 1 of 1993 a new licensing system has been introduced. The new Act and regulation lays down the legal framework for the regulation of mining and development of a minerals other than gems and hydrocarbons. The Act further proposes to harness the immense potential and initiative of the private sector to give a thrust to industrial development. A list of guidelines have been prepared for mining and quarrying operations. Divisional Secretaries of the various districts will assist in the issue of licenses for artisanal (small scale mining) and quarrying operations.

8.2 The GSMB is charged with the function of all activities concerned with mineral resource development in Sri Lanka and provides the institutional support structure to the entire mineral sector and administering the Mines and Minerals Act. It would be responsible for implementing the national mineral policy, issue of exploration licenses, mining licenses, industrial mining licenses, trading and special licenses including transport permits, control of mining operations, maintain mineral titling maps, maintain a computerised inventory of mineral resources, undertake research, carry out mineral exploration and mapping including other investigations, maintain analytical and other laboratories and regional geological centers and publish geological maps, bulletins and other documents, collect royalties and levies on mineral commodities including all other aspects concerned with the geology and mineral resources of the country.

8.3 Mineral Development Projects will be subject to approval under provisions of the National Environmental Act No. 47 of 1980.

8.4 Application forms for the issue of various licenses should be obtained from the office of the Director, GSMB or his representative. Authorities responsible for the issue of various licenses should be mindful of the numerous laws and regulations which are listed in the following documents:

- i. Mines and Minerals Act No.33 of 1992
- ii. Mining (Licensing) Regulations No. I of 1993
- iii. Guidelines for quarrying and mining.

8.5 The central government in consultation with the Ministry in charge of the subject of mineral resources development shall continue to formulate the legal aspects for the regulation of mining activity and the development of mineral resources. This has been considered necessary as substantial benefits can accrue from a properly structured and administered mineral industry.

9. Institutional Responsibilities

9.1 Information about technological changes in the mineral industry such as substitution of mineral raw materials or products made from such minerals will be obtained and disseminated to all concerned with mineral activity by the various institutions charged with the function of mineral resource development.

9.2 Special consideration would be given to infrastructure facilities development in remote rural areas where large or small scale mining operations have been established in order to help the economic upliftment of the local population.

9.3 Effort would be made to ensure that adequately qualified persons are available for the development of the mineral sector through state and private sector institutions and universities where basic facilities are already available for teaching and research in geology, mining, mineral processing and metallurgy. Encouragement would also be given to improve available facilities in these institutions and universities.

10. Mineral Research and Industrial Development

10.1 The development of a country is vitally linked with the development of its industrial and other minerals. Development should therefore be geared to the satisfaction of needs, it must be endogenous in character and must be in harmony with the environment. Activities in the mineral sector comprises mineral exploration, mining, and processing and end products development for export purposes where possible. It is to these areas, broadly operating that, the generation, importation and absorption of technical knowledge would be directed.

10.2 The GSMB shall implement the national mineral resources management policy and will be the organization charged with the function of mineral resources development whilst administering the Mines and Minerals Act and regulations framed thereunder.

10.3 The GSMB shall identify national requirements for mineral raw materials in existing and planned industries and stimulate the growth of the sector through initiation of and participation in feasibility studies. It shall also carry out analytical testing of mineral raw materials and maintain a minerals data base.

10.4 The NARA is the organization charged with the function and responsibility of carrying out and co-ordinating research, development and management activities in the subject of aquatic resources (living and non-living). Consideration will also be given to the potential of marine resources and their eventual development and the GSMB shall work in close association with NARA.

10.5 Industrial research and industrial development are not independent but interdependent. The value of independent in-depth evaluation of research activity in the mineral sector and to assess its impact on national development will be given serious consideration. Regional management must also design the over-all organization to obtain a maximum transfer of useful research and technology into operations.

10.6 All minerals are vested in the Republic. The Government shall encourage research on minerals and mineral based industries. Every possible assistance will be given to the researchers to have easy access to any information they need, to carry out their research on minerals without any hindrance.

11. Conclusions

11.1 With the structural reforms initiated by the Sri Lanka government, the country is now poised for rapid economic growth and creation of a conducive environment for inflow of foreign investment and technology.

11.2 Maintaining a strong and viable mining sector in Sri Lanka is a national imperative as mineral resource development is the prime requisite for industrial development and rapid economic growth. The manifold benefits of generation of employment, multiplier effect on the economy and exports and scope for domestic value addition warrant accordance of high priority to the mineral sector.

11.3 It is hoped that the initiative of the private sector and support of the government would usher in rapid mineral development and sustained economic growth.

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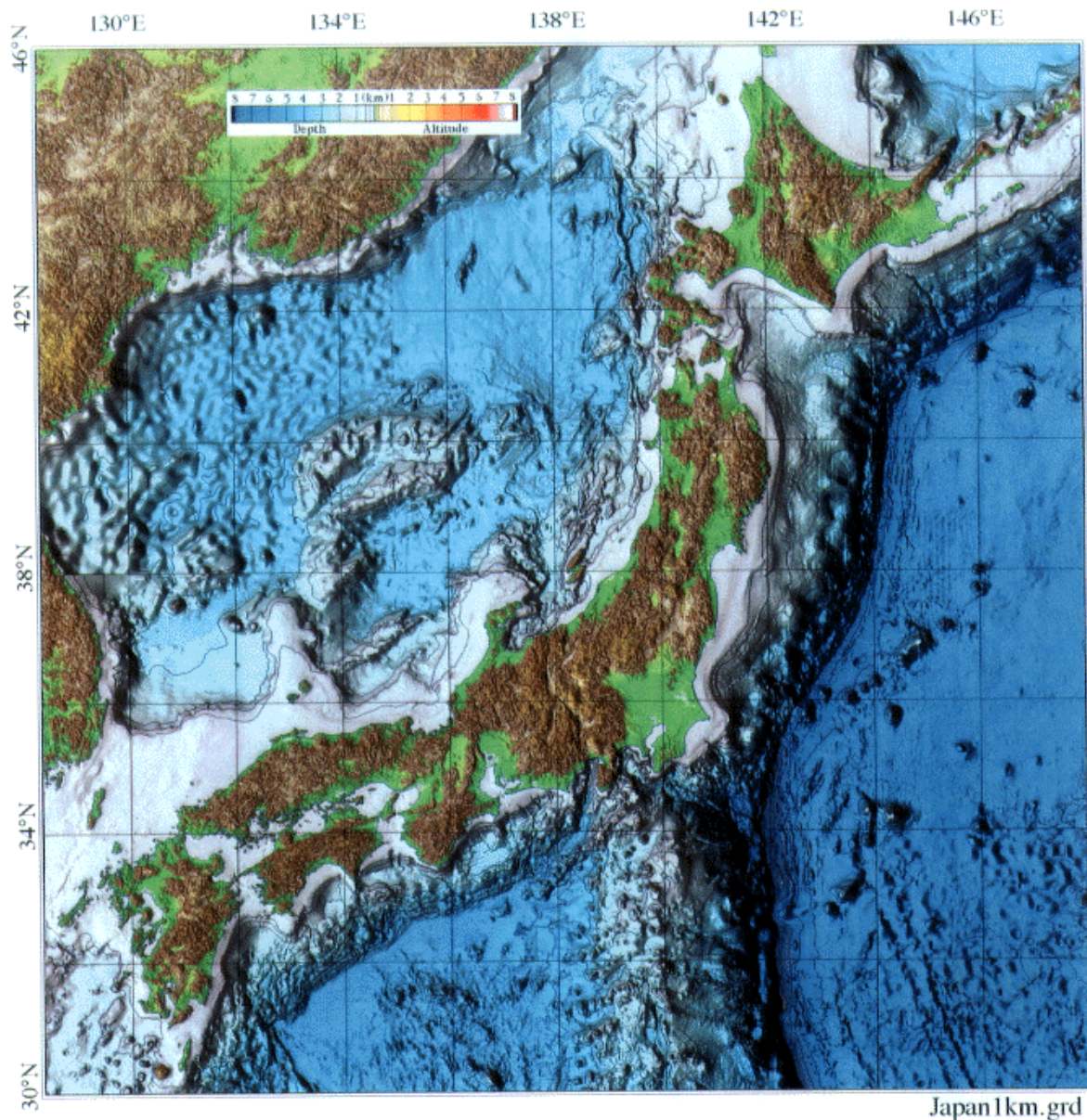
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Topographic image of Japan and its vicinity areas

1km (45" of longitude and 30" of latitude) gridded data set "Japan1km.grd"

The gridded data set was created by combining the following four gridded data sets.

- 1) 250 m (11.25" x 7.5") gridded data for Japanese land areas from Geographical Survey Institute,*
- 2) GTOPO30 (30" x 30") gridded data for land areas of the adjacent Asian continent available from <http://edcwww.cr.usgs.gov/landdaac/gtopo30/gtopo30.html>,*
- 3) 500 m gridded data for marine areas except western part of the Japan Sea and part of the Pacific Ocean from Hydrographic Department of Japan (HDJ),*
- 4) Predicted topography v.6.2 by Smith and Sandwell for the marine areas outside of the above HDJ data available from ftp://topex.ucsd.edu/pub/global_topo_2min/.*

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