From ICOGS Secretary for Asia and the Pacific

It is our great pleasure to send you the fourth issue of the ICOGS Asia-Pacific Newsletter in the first year of the 21st Century.

We have received contributions to the fourth issue from four organizations. The Lands Geological Survey Division, Mines and Geosciences Bureau Philippines sent us an article, "Geological hazards and their mitigation: the Philippine experience" as well as a short note, which introduces their organization. The Minerals and Geoscience Department Malaysia sent us a brief summary of the role of the department, whereas the Geological Survey of Bangladesh forwarded a short article on their present activities, which we actually received at the end of 2000. An article, with colourful figures and titled "Deformation of continental margin of Northeast Asia: tectonics and geodynamic modeling", which may be interesting for you, was submitted by Dr. E.A. Konstantiovskaia, Geological Institute, Russian Academy of Sciences. We would like to express here our sincere thanks to the contributors of these articles.

The Geological Survey of Japan was reorganized in April 2001. The details of the reorganization are described in an article, "The strategy and restructuring of the Geological Survey of Japan in April, 2001", which is actually to be presented at the CCOP meeting in October 2001. We hope this article would facilitate your understanding about the reorganization.

The list at the end of this issue, "Asia and the Pacific members of ICOGS", now includes the phone and facsimile numbers and e-mail addresses of member organizations. Hope this information as well as "Directory of Geoscience Organizations of the World", which we publish each year, would be useful for you in contacting each other. Although we checked the information by sending a letter by fax, mail or e-mail to each member organization before the publication of this issue, we are afraid that the list would be still incomplete. Please let us know if you find any inaccuracies in it.

All the past three issues of the ICOGS Asia-Pacific Newsletter can be downloaded from our web-site (http://www.gsj.go.jp/Intl/e-home.htm) now, and we also plan to make this issue available on the same web-site soon.

We would like to continue publishing the newsletter regularly. Any kind of information which may be of interest to other geological survey organizations will be accepted as an article for the future issues of the newsletter. Short articles such as news on recently published maps and other publications would be OK. We particularly welcome information such as new trends in your organizations and in your countries. All correspondence relating to the ICOGS Asia-Pacific including its newsletter should be addressed to:

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Bangladesh
GEOLOGICAL SURVEY OF BANGLADESH

The following article was submitted by Mr. A.K.M. Khorshed Alam,
Deputy Director (Planning) of the Geological Survey of Bangladesh.

Activities of the Geological Survey of Bangladesh (GSB) in 2000-2001

During the current year GSB has planned to carry on works on mineral exploration, geological mapping, coastal zone study, engineering geological mapping, urban geological and natural hazard studies, study of arsenic contamination in ground water, research in the field of geology, geophysics and chemistry. Some of the major programmes are given below.

- Geological Mapping - This programme will be implemented in three areas of the country in the north-western and mid-north parts covering about 1000 square kilometres.
- Mineral Exploration - GSB has planned for drilling 3 holes in the north-western part of the country where the basement lies at shallow depth--among these one for metallic mineral, one for coal and one as a part of reserve estimation of a coal basin. Drilling of the 1st hole has been completed and that of the 2nd hole is going on.
- Geophysical Mapping - This mapping includes surveying using gravity, magnetic, electrical resistivity and induced polarization methods, and geophysical logging of drill holes in the north-western part of the country.
- Analytical Chemistry - For the identification of the presence of toxic elements in the soil, and surface and subsurface water of Dhaka city and its surrounding areas studies will be carried on.
- Arsenic contamination investigation - Since the beginning of the last decade arsenic contamination in ground water of many parts Bangladesh has become serious issue to the human health. GSB started working to find out the source and the mobility of arsenic in the ground water. Presently, scientists are working in the mid-eastern and south-western parts of the country.
- Coastal and Marine Geology - In the coastal areas of the country mapping and collection of relevant data are being done in order to determine the sedimentation pattern of Holocene time and to assess cyclone hazard.
- Urban & Environmental Geology and Natural Hazard - This new branch has started functioning from this year. Programmes on 3-D GIS modelling on urban and environmental geology of Dhaka city, and environmental effect due to urbanisation and water logging problems.
- Engineering Geology and Water Resources - Programme of the branch includes preparation of engineering geological mapping in an area near Dhaka city.
- Research and Human Resource Development - A programme is being implemented to train a number of young geologists in the field of application of remote sensing in geology. Another programme with the aim of creating a database on earthquake has been taken. Other works include research on Quaternary geology, stratigraphy and environment.
- Co-operative Programmes - GSB provides assistance to other government, non-government and academic institutions in related fields. With the request of the Ministry of Disaster Management, Relief and Rehabilitation GSB is preparing an earthquake map of Dhaka city and its surrounding areas.

Besides these, other branches of the department will perform their normal duties.

Malaysia
MINERALS AND GEOSCIENCE DEPARTMENT

The following article was submitted by Dr. Chu Ling Heng,
Director-General of the Mineral and Geoscience Department Malaysia.

ROLE OF THE MINERALS AND GEOSCIENCE DEPARTMENT MALAYSIA

Since 1 July 1999, the former Geological Survey Department Malaysia and the Mines Department Malaysia have been merged into a new organization named the “Minerals and Geoscience Department Malaysia”. The role of this new department is to facilitate the systematic development and diversification of the country's mineral industry in a more co-ordinated manner and to intensify the use of geoscience for socio-economic improvement. Its main activities are mineral exploration, mineral economics, mine enforcement, geological mapping, hydrogeology, engineering geology, environmental geology, information management, laboratory-field consultancy services, and R&D activities with special focus on minerals.

As the national organization responsible for procuring basic mineral and geoscience data for multi-purpose usage, the organization has formulated strategic plans to:

- complete the country's minerals database through reconnaissance geochemical sampling and offshore surveys and to assess and characterize the industrial and energy mineral resources available;

- undertake priority geological mapping at appropriate scales over areas identified for development, areas with mineral potential, and areas earmarked for other geoscience investigations. e.g., hydrogeology, engineering geology and environmental geology;

- explore and develop groundwater in water-stress areas, as well as to systematically assess the groundwater potential of the country with the aim to complete a hydrogeological database;

- undertake focussed R&D on local minerals with the aim of producing value-added industrial materials on a laboratory-scale for possible development into commercial propositions.

The implementation of the department's mineral and geoscience programmes in the new millennium will be client-and needs-driven. To satisfy the needs of its clients, emphasis will be on the provision of quality information and services, including the need for the department to strive towards ISO certification for certain core activities. The department's policy is not to compete with but to complement the private sector; the longer term strategy is to encourage the private sector to fully develop its capabilities to provide such services, if possible.

To meet the objectives of the department's planned strategies for the longer term in relation to the aspect of data gathering for multi-purpose usage, we expect an increasing inclination towards outsourcing of selected activities.

The use of IT as an enabling tool is being intensified to transcend all levels of activity, from data organization, analysis and database development to dissemination. The vision finally is to set in place a globally-linked networking system to facilitate an efficient and effective avenue for interaction and transaction. The new millennium should also witness greater commitments on e-government applications and concerted efforts to adhere to the government's policy on paperless bureaucracy.

Linkages with agencies, institutions of higher learning and industries involved in minerals and geoscience at the local, regional and international level will continue to be enhanced.

Philippines
MINES AND GEOSCIENCES BUREAU

This article was submitted by Mr. Romeo L. Almeda,
Chief, Lands Geological Survey Division, Mines and Geosciences Bureau.

HISTORY OF THE MINES AND GEOSCIENCES BUREAU AND ITS GEOLOGICAL FUNCTIONS

Mines and Geosciences Bureau of Mines
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Geological studies in the Philippines are not confined to the functions of a single agency. Along with the Philippine Institute of Volcanology and Seismology (PHIVOLCS), the University of the Philippines - National Institute of Geological Sciences (UP-NIGS) and the Department of Energy (DOE), the Mines and Geosciences Bureau (MGB) serves as the government's instrument in the conduct of geological research and services in the country.

1.0 History of the Mines and Geosciences Bureau

The Mines and Geosciences Bureau was initially known as the lnspeccion General de Minas during the Spanish times. Its prime function then was the administration and disposition of minerals and mineral lands. The agency's abolishment in 1886 led to the transfer of its functions to the General Director of Civil Administration.

During the American occupation in 1900s, the General Directorate of Civil Administration became the Mining Bureau. Five years later, the Mining Bureau and the Bureau of Government Laboratories were fused under the name of Bureau of Science, and the Mining Bureau became the Division of Geology and Mines. In 1933, the Mineral Lands Administration Division of the Bureau of Lands was fused with the Division of Geology and Mines to form the Division of Mineral Resources under the Department of Agriculture and Commerce. It was during this time that the significance of coal and petroleum deposits was recognized. In the following year, the functions of the Division of Mineral Resources were placed under the direct supervision of the Director of the Bureau of Science, and the name of the Division was changed to Division of Mines.

The Commonwealth Constitution provided for the creation of the Bureau of Mines and of the first Philippine Mining Act in 1936. Thus, the reconstitution of the said Bureau. With the reorganization of the government under the puppet Philippine Republic in 1944, the Bureau was made the Division of Mines under the Department of Agriculture and Natural Resources. The re-establishment of the Philippine Commonwealth in 1945 led to the reorganization of the Bureau of Mines. In 1974, direct supervision and control of the Bureau was transferred from the Department of Agriculture and Natural Resources to the Department of Natural Resources. It was in 1982 that the Bureau of Mines was changed to the Bureau of Mines and Geosciences. Finally, the Mines and Geosciences Bureau was established in 1988, after the People Power Revolution with the reorganization from a line Bureau into a staff Bureau. The structure of the present MGB ultimately stems from the promulgation of the Mining Act of 1995.

2.0 Geological Functions of the Mines and Geosciences Bureau of Mines

The role of the MGB in evaluating the geology of the Philippines is particularly designated to the Lands Geological Survey Division (LGSD) and the Marine Geological Survey Division (MGSD). Both divisions are research and services oriented, performing well-delineated functions that actually complement each other. The LGSD is responsible for the on-shore geological studies of the MGB in the country. Its functions are shared by the seven (7) sections:

1. Geological Laboratory Services Section
2. Geological Database and Information System Section
3. Environmental Geology and Hydrogeology Research Section
4. Geological Survey Research Section
5. Metallic Mineral Deposits and Ore Genesis Research Section
6. Non-Metallic Mineral Deposits Section; and
7. Urban Geology Section

The Geological Laboratory Services Section conducts the laboratory functions of the Division. It performs gemology, megascopic and microchemical testing, sedimentology and clay mineralogy, petrography and fluid inclusion analysis, X-ray diffraction and X-ray fluorescence, carbon-14 dating, paleontological studies, and water quality and soil analysis. Its laboratory equipment is housed in the two-storey PETROLAB building specially designed for petrological and mineralogical research.

The Geological Database and Information System Section is responsible in compiling and archiving pertinent geological data, which are later transformed to digital format and processed in a geographic information system platform. It also functions to develop database and desktop mapping systems for project monitoring, mineral resources inventory and other related geological applications. In general, it acts as an over-all consultative body on GIS-based geo-information and computer technology for geological applications.

Hydrogeological investigations, groundwater resources assessment, geotechnical engineering assessment and waste disposal management studies are generally conducted by the Environmental Geology and Hydrogeology Research Section. These studies are conducted throughout the country with the help of personnel from the Regional Offices.

In the Geological Survey Research Section, geological quadrangle mapping and remote sensing studies are conducted with the end result aimed at the production of geological maps for the whole Philippines. These maps are later used by both the Government and the private sector in mineral exploration, geohazard identification and monitoring.

The Metallic Mineral Deposits and Ore Genesis Research Section updates the inventory of mineral deposits and does geologic and geochemical exploration studies for additional metallic deposits. In addition to this, the section identifies possible techniques for mineral exploration.

Vis-à-vis the preceding section, the Non-Metallic Mineral Deposit Section conducts similar activities on non-metallics. Such studies are aimed at the identification of materials for use in environmental protection, construction, ceramics, cement, agriculture and livelihood industries.

The recently created Urban Geology Section functions as a research and development consultative body tasked to formulate recommendations to the MGB Director. It performs as a regulatory body empowered to conduct project feasibility assessments, which include geological hazards, slope stability and ground deformation, subsurface geology, erosion control, and GIS-based urban geology.

The offshore geological studies of the Bureau are handled by the Marine Geological Survey Division. The Division complements the functions of the LGSD with the use of the 500-ton RPS Explorer, the only research vessel in the Philippines designed for marine geological surveys.

The Division carries out mapping of the seabed for the identification and assessment of coastal and aquatic mineral resources. It conducts marine environment geochemical surveys, the samples brought to the PETROLAB for initial analysis. Geophysical studies and sea bottom topographic bathymetric surveys are also performed, with the use of seismic reflection surveys. The collected data are used as database for further research studies. Finally, the Division identifies marine hazards and formulates recommendations for engineering works and planning design.

In general, both Divisions have been responsible for the acquisition of major geological information in the entire archipelago. Collaborative efforts with the major PHIVOLCS, UP-NIGS and DOE and foreign counterparts have likewise produced considerable advances in the science of Geology in the Philippines.

ROSTER OF LGSD PERSONNEL

OFFICE OF THE CHIEF

Romeo L. Almeda - Division Chief

Lida Miranda	Teresita Obias	

ENVIRONMENTAL GEOLOGY AND HYDROGEOLOGY RESEARCH SECTION

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Abraham Gatdula	Resty Gomez	Ricarte Javelosa
Lutgardo Laraño	Eleazar Mantaring	Marnette Puthenpurekal

GEOLOGICAL SURVEY RESEARCH SECTION

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Melanio Dones, Jr.	Romiro Encina	Aurelio Gutierrez
Salvio Laserna	Michael Lituañas	Dilson Montano

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Fernando Sajona	Rogel Santos	Joselito Velasquez

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Aeschylus Valenzuela		

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Bernardo Lanuza	Enrique Maglanque	Ma. Malyn Tumonong
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Megascopic Laboratory Unit — Jocelyn Villanueva - Unit Head

Lourdes Reyes, Cesar de Veyra

X-ray Laboratory Unit

Leticia Santos, Nympha Pajarillaga

C-14 Laboratory Unit

Lolita Broces - Unit Head

Paleontology Laboratory Unit — Maybelyn Zebeda - Unit Head

Raymond Thaddeus Ancog, Elsa Mula

Water Quality Laboratory Unit — Editha Macalalad - Unit Head

Dahlia Almosara, Roberto Avellana

Gina Flor Frankera, Josephine Uyaco

Geochemical Exploration Laboratory Unit — Teresita Balmes - Unit Head

Joel Almosara, Dahlia Apodaca

Jaime delos Reyes, Marietta Detera

Eleonor Lobendino, Carmelita Yalong

Sample Preparation and Gemology Unit

Wenceslao Mago, Mario Asis

Antonio Guansing, Jr., Wilfredo Villanueva

Maintenance Unit — Cielo Gamus - Unit Head

Isauro Dorosan, Esteban Dulay

Library and Documentation Staff

Lilia Estopace

Clerical Staff

Helen dela Cruz, Elena Fetiza

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Reynaldo Villela - Section Chief

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Expedito Soria	Raul Dimalanta	

MARINE MINERAL EXPLORATION SECTION

Edgardo Gonzales - Section Chief

Reynaldo Rodelas	Edgardo Diez	Danilo Octaviano
Corazon Ferrer		

MARINE TECHNOLOGY SECTION

Pancho Caculitan - Section Chief

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Federico Balanon		

MARINE COASTAL GEOLOGY SECTION

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Joel Natividad	Michael Jara	Leopher Dagdag
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Robert Calugay	Ramoncito Rivera	

DATA PROCESSING AND INFORMATION TECHNOLOGY SECTION

Marcelo Alilio - Section Chief

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Ruben Natividad	Mario Jandumon	Crisostomo Masangkay
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GEOLOGICAL HAZARDS AND THEIR MITIGATION: THE PHILIPPINE EXPERIENCE

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1.0 Philippines As A Geohazard-Prone Country

The Philippines has had a fair share of natural disasters. In a number of instances, these catastrophes had resulted in the loss of countless lives and wrought damages to properties running into millions of pesos. The August 03 Cherry Hills Subdivision Landslide Incident in Antipolo City near Metropolitan Manila which took the lives of 58 people, highlights the country's predisposition to natural hazards and brings to the fore how such situation can take the scale of a tragedy when planning approaches is not supported by information on the vulnerability of the environment (Fig. 1).

Figure 1. Cherry Hills Subdivision Landslide Incident in Antipolo City, Sub-urban Manila.

A number of factors contribute to the proneness of the country to geological hazards[1]. One of these factors is the tectonic setting of the country. The Philippines is a very seismically active region bounded by trenches and transected by several active faults (Fig. 2). These geologic features act as earthquake generators in the archipelago, which induce hazards such as ground shaking, ground rupture, liquefaction, landslides and tsunamis (Fig. 3). The country is also host to more than 200 volcanoes, 22 of which are considered active (Fig. 2). Activity of these volcanoes causes earthquake and create ground fractures. The more devastating effects of volcanic activity, however, were demonstrated by the Mt. Pinatubo eruption in 1991, where several parts of Central Luzon have been affected by pyroclastic flows, ashfall and lahar flows (Fig. 4).

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[1] **Geologic hazards- refer to natural and man-induced geological processes that have the potential to cause destruction and pose a threat or risk to man's life and property.**

Geographically, the Philippines is bounded by large bodies of water. This makes several portions of the country prone to coastal erosion. Other than this, the archipelago lies along the path of air streams (*e.g.* NE and SW monsoons) and several tropical storms that induce hazards such as flooding and landslide. The occurrence of such hazards is further promoted by the country's rugged terrain in which over 60% of its land consists of slopes. Such terrain favors rapid run-off concentration that could result to flooding in basinal or flat-lying areas. Uplift of the land could result to oversteepening of slopes, a factor that could in turn initiate landslides.

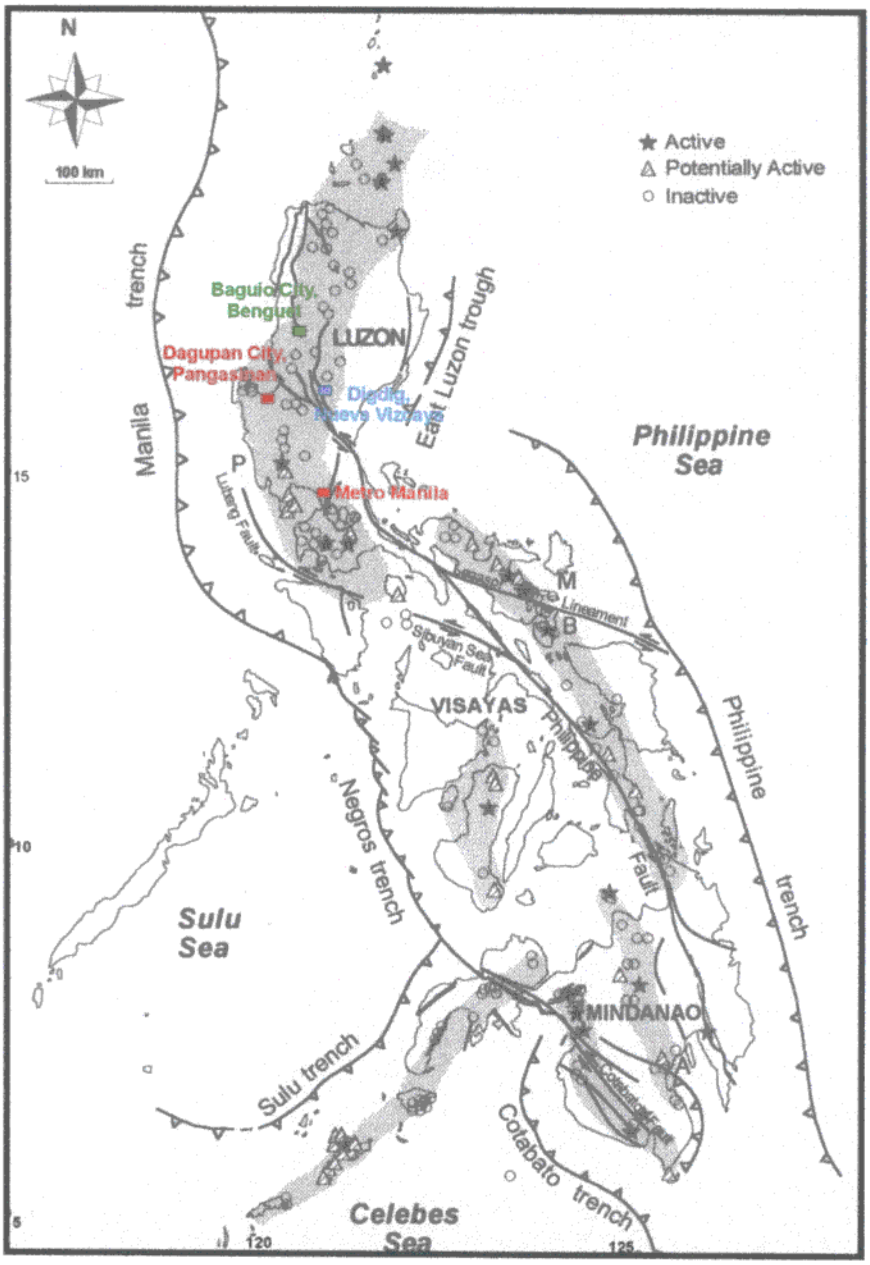

Figure 2. Tectonic features and distribution of Quaternary volcanoes and active volcanic belts in the Philippines. **P**-Mt. Pinatubo, **T**-Taal Volcano, **M**-Mayon Volcano, **B**-Bulusan Volcano, **A**-Mount Apo (Modified after PHILVOLCS, 2000)

Indeed, natural hazards in the Philippines are common that it has experience the most natural hazards in the twentieth century (Kovach, 1995). To therefore adequately and comprehensively address and mitigate the possible effects or impacts of geologic hazards, the Department of Environment and Natural Resources (DENR) Philippines promulgated the

DENR Administrative Order Number 28, Series of 2000, otherwise known as the DAO 2000-28-" Implementing Guidelines on Engineering Geological and Geohazard Assessment as Additional Requirement for Environmental Compliance Certificate (ECC) Applications Covering Subdivision, Housing and Other Land Development and Infrastructure Project". This issuance toook effect on March 14, 2000.

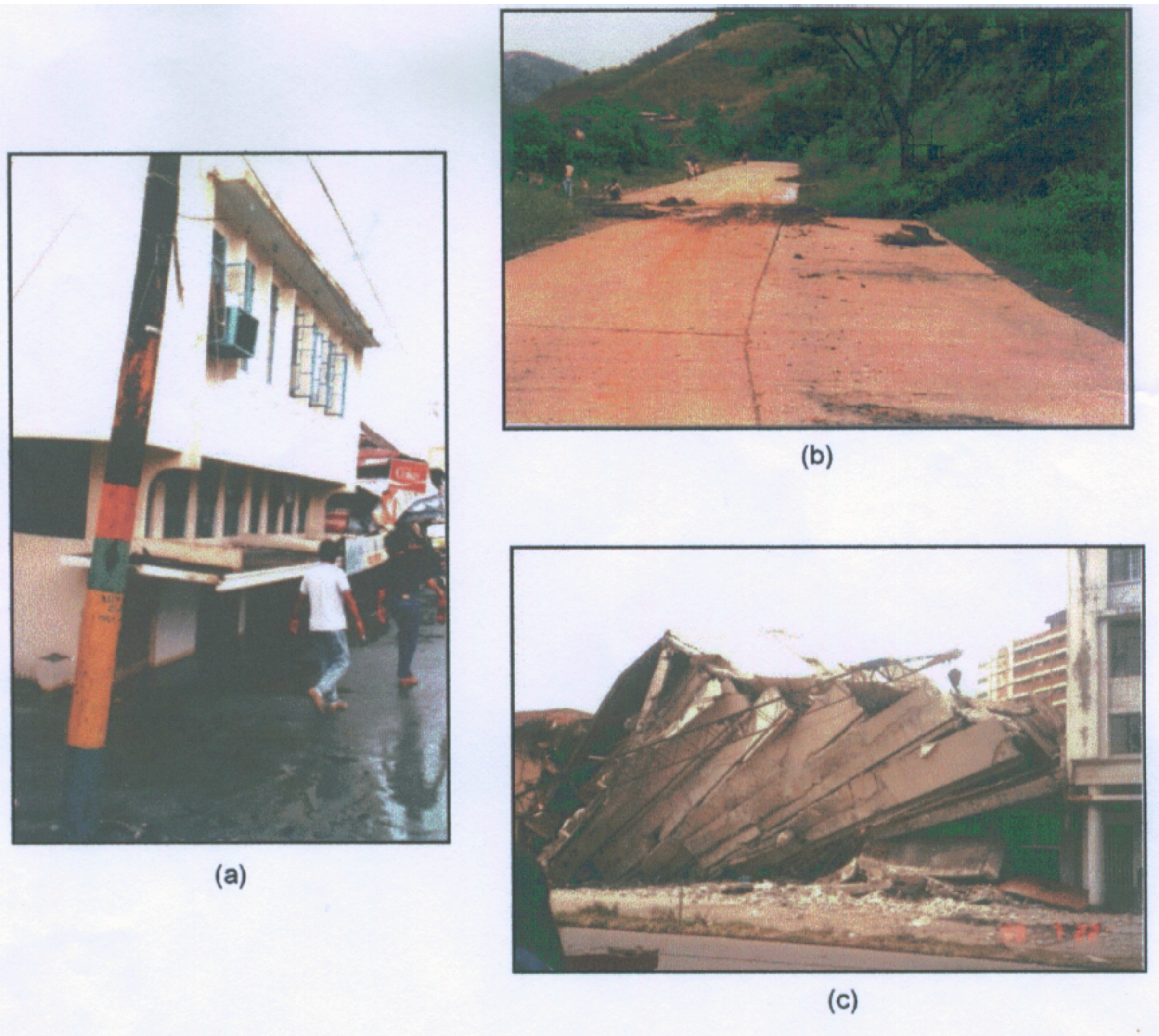

Figure 3. Geohazards associated with the July 16, 1990 earthquake that struck Luzon island (Refer to Figure 2 for location).
(a) Tilted houses as a result of liquefaction in Dagupan City, Pangasinan City
(b) Ground rupture in Dalton pass, Digdig, Nueva Vizcaya
(c) Collapsed structure as a consequence of ground shaking in Baguio City, Benguet Province.

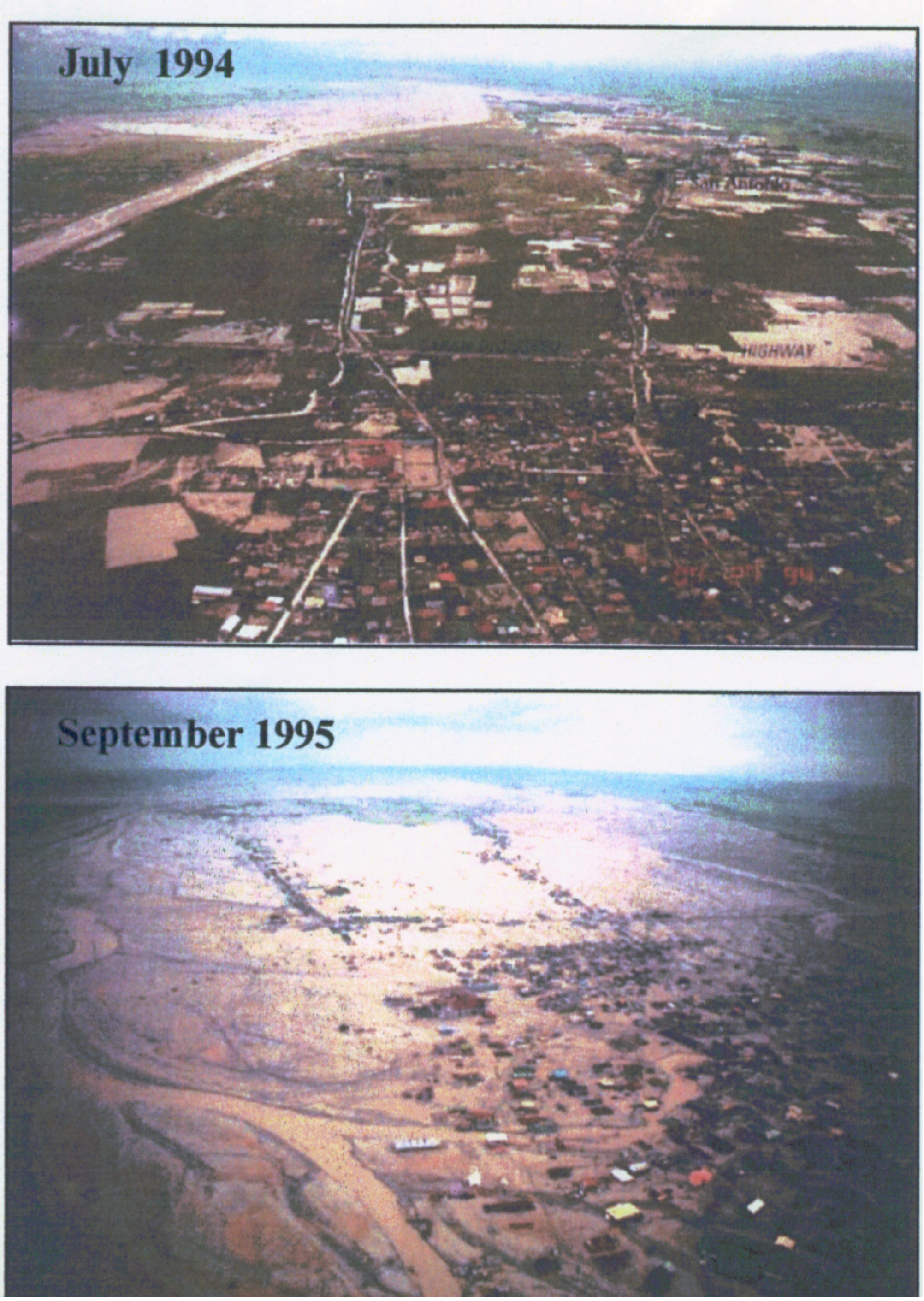

Figure 4. Aerial view of a portion of Zambales Province area before and after the onslaught of lahar flows (Source: Punongbayan et al., 1996)

II. The DAO 2000-28

The DAO 2000-28 requires all proponents of subdivision development projects, housing projects and other land development and infrastructure projects, private or public, to undertake an Engineering Geological and Geohazard Assessment (EGGA) as part of the procedure in the application for an Environmental Compliance Certificate (ECC)[2]. In fulfillment of this order, the proponent follows certain procedures as outlined in Figure 5.

The geological site scoping of a project site is conducted by MGB geologist/s. A corresponding Geological Site Scoping Report (GSSR), to be given to the project proponent, is prepared by the MGB. The GSSR contains the recommendations on the scope of work of the Engineering Geological and Geohazard Assessment (EGGA) to be conducted by the proponent's geologist or engineer. The EGGA report (EGGAR) is then submitted to the concerned MGB Office.

In the event that a technical report[3] of the project site is already available prior to conduct of geological site scoping, the MGB geologists conduct geological verification of the project site. The MGB geologists prepare a corresponding Geological Verification Report (GVR) to be submitted to the proponent. The GVR contains the findings arrived at or data generated during the conduct of the geologic verification and indicates the deficiencies or inadequacies of the submitted document for appropriate action by the proponent. Upon revision of the technical report by the proponent in accordance with the stipulations in the GVR, the proponent submits the said report (now considered EGGAR) to the concerned MGB Office.

The EGGAR is reviewed by the MGB Technical Review Committee (TRC). After reviewing the report, the TRC prepares a corresponding Geological Review Report (GRR). This report includes a review of the findings of the EGGA or an equivalent technical report and indicates deficiencies and inadequacies of the submitted document based on the GVR for compliance by the proponent. Once the project proponent has satisfactorily complied with the stipulations or additional requirements imposed by the TRC, the final GRR is issued by the TRC to the proponent. A copy of the final GRR along with a copy of the EGGAR is submitted by the MGB to the Environmental Management Bureau (EMB) of DENR. The final GRR contains, among others, the recommendations of the MGB-TRC to the EMB Review Committee.

To insure smooth implementation, DAO 2000-28 also provides for the formation of an Urban Geology Unit in all MGB regional offices. The members of the Urban Geology Unit oversee the conduct of geological site scoping, verification and review of the EGGAR. The unit may seek the technical advise from experts from other agencies with respect to geotechnical engineering aspects and other specialized studies, if deemed necessary.

3.0 Implications to Land Use Planning and Disaster Preparedness

The Philippines, by reason of its geographic location and geologic character/history, is prone to natural disasters particularly earthquakes, typhoons, floods, and mass movements. The lack

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[2] Environmental Compliance Clearance (ECC) - issued by the DENR Secretary or the Regional Executive Director certifying that based on the respresentations of the proponent and as reviewed and validated by the Environmental Impact Assessment Review Committee (EIARC), the proposed project or undertaking will not cause a significant negative impact; that the proponent has complied with all the requirements of the Environmental Impact System; and that the proponent is committed to implement its approved Environmental Management Plan in the Environmental Impact Statement or mitigation measures in the Intitial Environmental Examination.

[3] A technical report to be considered by MGB for verification/review may be equivalent geological/geohazard assessment report, an Initial Environmental Examination (IEE) or Environmental Impact System (EIS) document containing substantial information and evaluation as per MGB Memorandum Circular No. 2000-33.

of consideration on the part of developers/project administrators to the natural environment during land development has led to numerous problems as well as tragic incidents involving loss of lives and properties. Similarly, in the past, there has been a general absence of a systematic and sound land use plan in both the local and national level. This has led to a rather haphazard manner of designating the use of a particular section of land. In many cases the allocated land use is not suitable for the type and physical character of the land.

The rationale behind the issuance of DAO 2000-28 is for the proponents to recognize and properly consider the possible impacts natural hazards might have on their projects. Once the dangers are identified, appropriate mitigating measures can be adopted to minimize if not totally eliminate these dangers. The MGB has also embarked on a comprehensive campaign to inform the populace of the dangers being posed by natural hazards. Maps showing areas prone to different types of natural hazards are being produced in various scales to serve the needs of local governments and development planners. These include hazard zonation and risks maps of particularly vulnerable areas of the country. The MGB also conducts lectures and disseminates reference materials (*e.g.* posters, pamphlets) to students, teachers and the general public. Learning the basic principles behind the occurrence and recognition of geological hazards is the first step in minimizing the effects of hazards.

4.0 References

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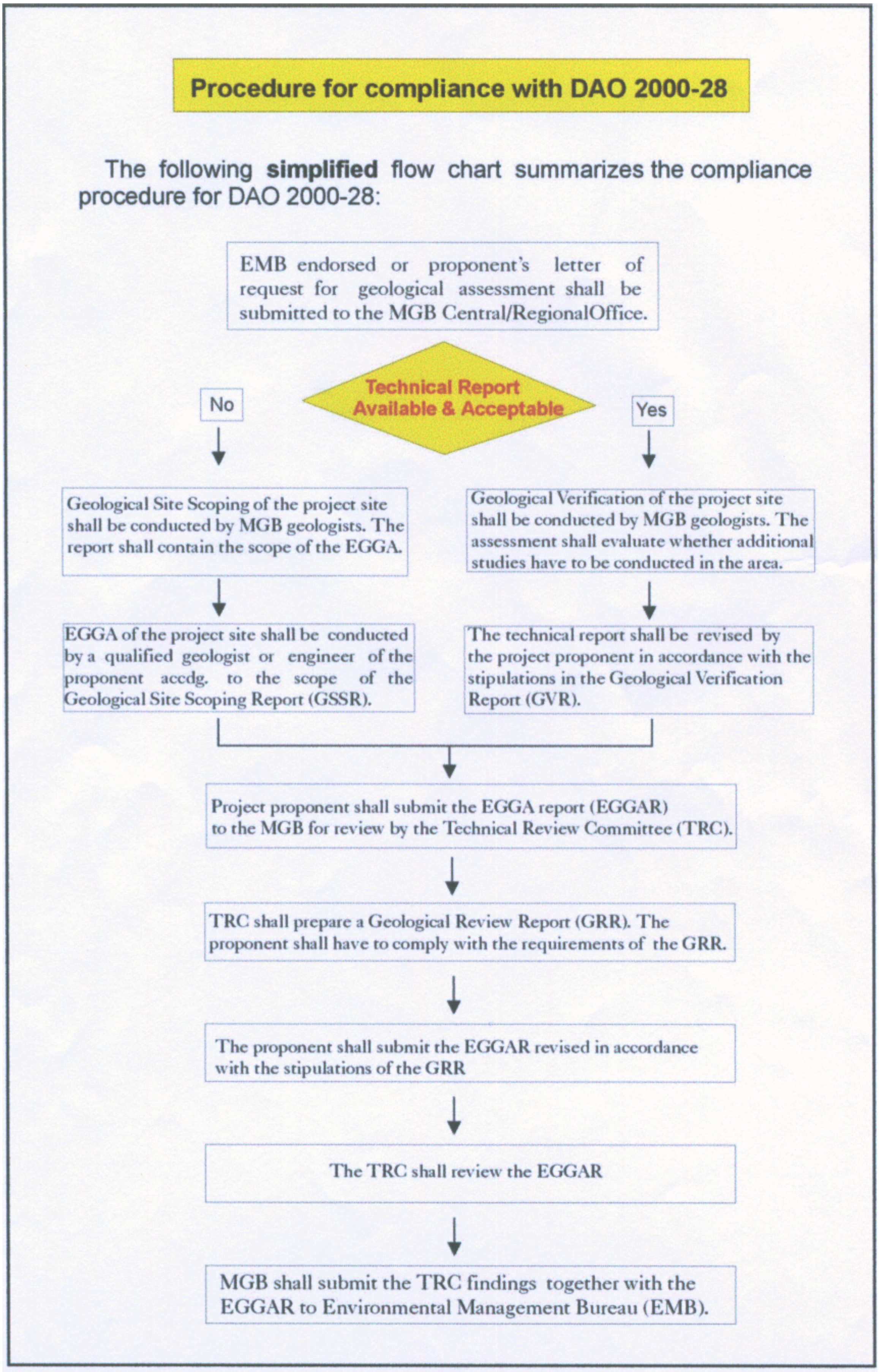
Procedure for compliance with DAO 2000-28
The following simplified flow chart summarizes the compliance procedure for DAO 2000-28:
EMB endorsed or proponent's letter of request for geological assessment shall be submitted to the MGB Central/RegionalOffice.
Technical Report Available & Acceptable
No
Yes
Geological Site Scoping of the project site shall be conducted by MGB geologists. The report shall contain the scope of the EGGA.
Geological Verification of the project site shall be conducted by MGB geologists. The assessment shall evaluate whether additional studies have to be conducted in the area.
EGGA of the project site shall be conducted by a qualified geologist or engineer of the proponent accdg. to the scope of the Geological Site Scoping Report (GSSR).
The technical report shall be revised by the project proponent in accordance with the stipulations in the Geological Verification Report (GVR).
Project proponent shall submit the EGGA report (EGGAR) to the MGB for review by the Technical Review Committee (TRC).
TRC shall prepare a Geological Review Report (GRR). The proponent shall have to comply with the requirements of the GRR.
The proponent shall submit the EGGAR revised in accordance with the stipulations of the GRR
The TRC shall review the EGGAR
MGB shall submit the TRC findings together with the EGGAR to Environmental Management Bureau (EMB).

Figure 5

Japan
GEOLOGICAL SURVEY OF JAPAN/AIST

This article was submitted by Dr. Yoshinori Miyazaki,
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THE STRATEGY AND RESTRUCTURING OF THE GEOLOGICAL SURVEY OF JAPAN IN APRIL, 2001

The Geological Survey of Japan/AIST

1.0 Institutional Reform Process

There is an increasing need from society to the government to challenge various issues of the modern world. In order to meet the needs, the Japanese Government had reorganized the entire Ministries and their related institutions and agencies on January 6, 2001. Due to the entire reform program of the Japanese government, the former Agency of Industrial Science and Technology of the Ministry of International Trade and Industry (MITI) was reorganized on April 1, 2001 to the new National Institute of Advanced Industrial Science and Technology (AIST). AIST is currently an Independent Administrative Organization[1] and being supervised by the newly created Ministry of Economy, Trade and Industry (METI). The former Geological Survey of Japan (GSJ) which was part of the Agency was also reorganized into five research units, three research support divisions, and two collaborative teams within AIST in order to undertake and achieve their geoscience needs (refer to Table1). This country report is to introduce the reform efforts of the Japanese government and its new framework for a geoscience institution in the 21st century.

On April 1, 2001, 15 research institutions under the Agency of Industrial Science and Technology/MITI, including the Geological Survey of Japan, were also reorganized to an Independent Administrative Organization that is the National Institute of Advanced Industrial Science and Technology (AIST). Although the former Agency had significantly contributed to the development of applied science and industrial technology, AIST has been established to realize better research environment. The AIST holds about 2,400 research scientists and is the largest government research institution in Japan. “Tsukuba Science City” of Ibaraki Prefecture is the center with several research divisions throughout Japan in order to respond to the situation stated below.

Next year is our organization’s 120th year anniversary. This paper reflects our new organization, which is still in transition. It will become more flexible and responsive in addressing the challenges and opportunities in the 21st century. We will remain a successful organization by embracing these changes satisfying our clients and users while maintaining and raising our high-level scientific research capabilities.

2.0 Status of Government Research Institutions

As government research institutions in Japan have shifted to basic scientific research after the mid 1980s, the academic presence of the institutions was significantly increased. Although the institutions gained attention as a center of excellence, the following issues have been raised:

1. Decreasing awareness of geoscience and measurement standard as a principal government role in basic research;
2. Decreasing awareness of respective scientists to meet the needs of the society;
3. Selection of priority fields of research were not made in a timely manner; and

4. Inefficient use of human resources.

Because of this recognition to the institutional mission in the rapidly changing world, AIST found recently its role to identify the most advanced scientific technology for society based on creative research activities and will undertake the following activities:

1. Compiling geoscience and measurement standard, as a principal role of the Government, for the base of industrial science and technology;
2. Undertaking long term and high risk research which are difficult for the private sector to undertake;
3. Taking the lead in research on energy and environment issues where the government has major responsibilities; and
4. Promoting technology integration to strengthen the industrial competitiveness and create new business opportunities.

3.0 Role of the Geological Survey of Japan/AIST

Since its inauguration in 1882, the Geological Survey of Japan had a proactive role in mineral resources evaluation to develop the state economy and reformed itself occasionally. The newly established AIST defines building a geoscientific knowledge base as one of the core activities of the institution as “intellectual infrastructure.” [4] As stated above, AIST currently has five research units, three research support divisions, and two collaborative teams for the geoscience sector. These units of geoscientific missions are now called “the Geological Survey of Japan/AIST”.

The new GSJ/AIST will contribute efficiently to the management of the nation’s resources and environment dealing with issues like contamination/pollution and natural/man-made hazards. The goal is to make a framework to create synergy of the organization’s expertise in geology, geophysics, geochemistry and hydrology to meet societal issues at the same time keeping diverse expertise.

In the five research units, there are two mission oriented research centers (Deep Geological Environments Research Center; and Active Fault Research Center) and three research units (Institute of Geoscience; Institute of Geo-Resources and Environment; and Institute of Marine Resources and Environment). AIST will periodically reorganize these research units by means of the following criteria: (i) specification of the mission of respective research units; (ii) advancing into new areas with different technology; and (iii) enhancing the relation across research units.

The mission oriented research centers are responding to the needs from society and receive priority in AIST to the budget and human resources allocation. These centers strategically implement the government programs and adopt a top down management due to its impact to society and industry. The three research units are undertaking long-term research activities to achieve their own mission with bottom up project management. As geoscience related issues, such as natural resources development, geohazard and environment management, requires a multi disciplinary approach, AIST established an internal geoscience sector board meeting with all related units and divisions in order to coordinate with each other and exchange information and views.

In terms of the geoscience aspects of AIST supporting divisions, the International Geoscience Cooperation Office belongs to the International Affairs Department and has the responsibilities in the planning and strategy for geoscientific research, and coordination of international geoscience projects. As part of the Public Relations Department, the Geological Survey Information Unit and Geological Museum improve public relations and disseminate the results of research activities.

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[4] Intellectual infrastructure is identified by METI as knowledge and information that need to be compiled in a systematic and consistent way for the social and economic activities of the country.

The research coordinator is responsible for the geoscience field belongs to the Collaboration Department. He coordinates work among all the geoscience-related research units and research support divisions. The research coordinator also promotes the technological transfer of research and development results to industry and encourage collaboration with industry, governmental and academic organizations for the geoscience sector of AIST.

4.0 Towards the future

As a member of Asia and Pacific Region, we believe that the mission of Japan is to contribute to the development and growth of the region. The region consists of various countries different in the condition of politics, economics and culture, and the issues on the development are diverse. Considering particularly the economic and social issues of each country, we are aiming to contribute as much as possible for the sustainable development. Although recent trends of globalization and liberalization are accelerating development in a certain area, our future effort should be focused on sharing the benefits of development in the world to meet their needs.

Japan's vision for the 21st Century is to pursue peace and prosperity based on the idea of respect for human beings with the main pillar of diplomacy as "Human Security". Japan has been making various efforts for international cooperation since ex-Prime Minister, Keizo Obuchi delivered his speech "For Building Asian Bright Future" in Hanoi in 1998. Needless to say, the main purpose of geoscientific cooperation in the Regions is to ensure the protection of the environment and develop the natural resources. We should also keep in mind that the purpose includes our contribution to the security for the people. Their existence is directly threatened by a shortage of water or food, disaster and environmental destruction, which are caused by globalization of the economy or the increasing number of local conflicts after the Cold War.

From these viewpoints, we will have an active commitment to social issues like environmental protection, natural disaster prevention, and resources and energy security. While continuously improving the collaborative relationship on research with advanced countries, we will understand and solve the important and serious issues characteristic to the East/Southeast Asia Regions where CCOP is taking the initiative. For many years Japan has fostered studies and assessments in the field of disasters like tsunami/earthquake, active faults, volcanic eruption, etc. It possesses the most advanced knowledge in this field. It is our responsibility and duty to use this knowledge to solve the problems of the Asian Regions having similar geologic conditions. Furthermore, we are deeply concerned with problems threatening directly human life such as contamination of surface/underground water, shortage of water resources, soil contamination, coastal erosion, ground subsidence, small-scale mining, desertification, etc.

In the advanced IT age, one of the most important and necessary tasks for CCOP or other geological organizations in the East and Southeast Asian Regions is to improve the database covering geological information of each country and promote its utilization. This task will contribute not only to build a secure integrated database of the nation's information in the Regions but also develop the infrastructure in information. Moreover, we hope that it will stimulate the local industry. In addition, we will work for the improvement of a practical database retrieval system, such as a retrieval system for standardized metadata like a clearinghouse of geological information that utilizes GIS (geographic information system) through the most advanced IT or a retrieval system by a map index access.

Since our country is the largest supporting country to ESCAP in the Asia Pacific Regions, our responsibility is of paramount importance. We hope that the new Geological Survey of Japan/AIST will contribute to strengthen further collaborative relationships with countries in the Asia Pacific Regions through CCOP, and develop a warm working relationship with

CCOP.

Table 1. The organization of new GSJ/AIST. "G.". and "R.G". indicate "Group" and "Research Group", respectively.

National Institute of Advanced Industrial Science and Technology (AIST)
President, H. Yoshikawa

Research Coordinator for Geological Survey, K. Kimbara

Research Center for Deep Geological Environments (K. Kodama)

General Geology Team
Geophysical Exploration Team
Groundwater Team
Crustal Fluid Team
Geodynamics Team
Rock Physics Team
Geochemistry Team
Integrated Geology Team

Active Fault Research Center (E. Tsukuda)

Active Fault Evaluation Team
Faulting Behavior Modeling Team
Earthquake Hazard Assessment Team

Institute for Geoscience (H. Kato)

Sedimentary Geology G.
Tectonics G.
Volcanic System R.G.
Plutonic and Metamorphic Geology G.
Integrated Geology G.
Integrated Bio- and Chronostratigraphy G.
Geophysical Mapping R.G.
Tectonophysics G.
Geochemistry G.
Micro-scale Isotope Geochemistry G.
Tectono-Hydrology R.G.
Earthquake Process R.G.
Experimental Earthquake Physics G.
Volcanic Activity R.G.
Magmatic Activity R.G.
Asian Geoinformation R.G.

Institute for Geo-Resources and Environment (T. Noda)

Geothermal Reservoir R.G.
Geo-Energy R.G.
Geothermal Resource R.G.
Fuel Resource Geology R.G.
Fuel Resource Geochemistry R.G.
Mineral Resource R.G.
Asia Geothermal R.G.
Exploration Geophysics Research Group
R.G. for Geo-Resource Development and Safety
Water Environment R.G.
R.G. for Geo-Technology and Environmental Assessment

Geoscience Information R.G.
Geologic Remote Sensing R.G.
Mineralogy and Paleontology R.G.

Institute for Marine Resources and Environment (T. Miyazaki)

Aquamaterial Separation Technology R.G.
Marine Biopolymers R.G.
Sea Floor Environment and Resources R.G.
Organo-mechanic Sea Floor R.G.
Underwater Technology R.G.
Global Marine Environment Charge R.G.
Coastal Environment R.G.
Coastal Ecosystem R.G.
Marine Biological Technology R.G.
Environmental Hydraulics R.G.
Marine Eco-material R.G.
Marine Geology R.G.
Marine Geophysics R.G.
Coastal Monitoring and Management R.G.

Collaborative Research Team of Geological Survey, AIST Hokkaido (E. Ohta)

Collaborative Research Team of Geological Survey, AIST Kansai (S. Yoshida)

Public Relations Department

Geological Museum (M. Bunno)

Geoinformation Division (Y. Kanazawa)
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International Affairs Department

International Geoscience Cooperation Office (Y. Miyazaki)
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5.0. Appendix

Research Units and Supporting Divisions of the Geological Survey of Japan/AIST

The goals and the activities of research units and supporting divisions are described below.

5.1. Research Center for Deep Geological Environments

More than 30% of the total electric power in Japan relies on nuclear power generators. After recycling plutonium and other elements from used nuclear fuel, high-level radioactive wastes are temporally stored as vitrified material. There is a plan to start nuclear wastes disposal in geological formations deeper than 300 m from the surface in the late 2030s. However, as high level radioactive wastes should be safely disposed from the society for longer than 100,000 years, it is critical for the stable energy supply in the 21st Century to undertake appropriate geological research on the management of high-level radioactive waste disposal.

This Research Center develops a methodology and compiles scientific data to assess the safety of nuclear waste disposal on a geologic time scale. The Center is assessing the long-term change of geological conditions and impact of tectonic movements caused by faulting and volcanic activities to some specific geological characteristics, such as groundwater circulation systems. The Center can undertake comprehensive research and compile a wide range of geological data with other research units of the Geological Survey of Japan/AIST. The Center has the following responsibilities to:

1. Compile earth scientific data regarding the nuclear waste disposal in a geologic formation, establish a suitable model for safety assessment of the radioactive waste disposal, and undertake long-term research and monitoring on a hydrogeology model;
2. Undertake regional surveys across NE Japan in areas of specific geological formations, analyze the process and mechanism of the long-term geologic change, undertake quantitative impact analysis and develop a prediction methodology;
3. Establish a national data base of geological characteristics for nuclear waste disposal and data processing system for geologic structure analysis; and
4. Identify elements and indexes concerning the issues of environment and geohazards in the geology formation and provide this data as geoenvironment maps to society.

In May 2000, the "Specific Radioactive Waste Final Disposal Act" was issued. Based on this Act, the Nuclear Waste Management Organization of Japan (NUMO) was established by the private sector as an implementation body for the nuclear waste disposal project. The NUMO has started research on the selection of the future disposal sites. As NUMO has the responsibility to build and operate the repository plant, close the facility in a safety manner, and undertake technology development to increase the operational efficiency. The government and its related institutions including the Geological Survey of Japan/AIST will carry out research and technology development for safety regulations and assessments, and activities to gain the trust of the people. It is important for the government to provide the scientific knowledge and information, and undertake publicity activities to increase the awareness of society about this matter.

5.2. Active Fault Research Center (AFRC)

The AFRC is one of the responsible organizations for active faults studies in Japan under the Headquarters for Earthquake Research Promotion. The AFRC provides innovative, reliable science to help reduce losses from future earthquakes and tsunamis. Scientists of AFRC help to define the fault activity, ground-shaking hazards, and tsunami related floods. They present their findings to public officials and the general public. They also work closely with related research institutes in other countries. AFRC is conducting the following research programs during the FY 2001-2004 to reduce seismic hazards such as the 1995

Hyogo-ken Nanbu (Kobe) Earthquake caused by movements of active faults. .

1. Study of active faults: The AFRC surveys active faults in Japan and estimate the probability of future earthquakes and its magnitude for each fault. The AFRC also studies large active faults overseas to improve the evaluation method of earthquakes on domestic large active faults such as the Median Tectonic Line or Itoigawa-Shizuoka T. L.
2. Assessing earthquake hazards: Combining information on geologic structures and active faults, AFRC estimates seismic hazards from ground shaking and fault displacements. We also study tsunami deposits preserved in geologic layers and make computer simulation of tsunamis.
3. Public outreach: The AFRC annually prints the Interim Reports on active faults and paleo-seismological studies. We also publish active fault strip maps and 1:500,000-scale seismotectonic maps. We plan to publish maps showing possible hazards from future earthquakes and tsunamis, in addition to maps showing rupture probabilities of major active faults in Japan. Information on these publications and on going research projects will be also available on our web site.

The AFRC has three research teams to operate the research programs.

1. Active Fault Evaluation Team: Major active faults are investigated with various methods such as geological mapping, trenching and drilling in order to evaluate the possibility of future rupture and earthquake magnitude. These results will be published as active fault strip maps and the maps of rupture probabilities for major active faults in Japan.
2. Faulting Behavior Modeling Team: The geometry, length, displacement and paleo-seismicity of the surface faults of recent earthquakes are studied to reveal the characteristics of fault segments. The team models faulting behavior using seismological and geodetic data for the evaluation of future earthquakes on long active faults. The North Anatolian fault and San Andreas fault, California, USA are two major international study fields of this team in cooperation with MTA-Turkey and USGS, respectively.
3. Earthquake Hazard Assessment Team: On the basis of active fault study and fault modeling, the ground shaking from earthquakes is estimated. The generation and propagation of seismic waves are simulated by considering various factors, such as the epicentral distance, the way the rupture propagates on fault, and subsurface structure. The generation and propagation of tsunamis and its possible damage such as flooding are also estimated. The team publishes hazard maps for earthquakes and tsunamis

5.3. Institute of Geoscience

This research institute is one of the core units of the Geological Survey of Japan/AIST. The mission is making baseline studies on geology, geophysics and geochemistry, and a geo-information study for industrial development and a better quality of life for the population. A particular concern is to enhance the understanding of the complex geologic processes of the active Japan island-arc system by performing geoscientific mapping, and research on earthquakes and volcanic eruptions for the prediction and prevention of the hazards

1. Geological research: The mapping projects and fundamental research on the regional geology of the Japanese Islands are carried out in collaboration with other research units and universities. At present about 70% of Japan has been mapped on a scale of 1:50,000. Other regional geological maps on scales such as 1:200,000, 1:500,000, 1:1,000,000 have been compiled for most of Japan.
2. Geo-information: The Institute makes computer applications for geoscience including

digital mapping, developing a database for satellite remote sensing and information on geological specimens as standard materials for geoscience. In addition, it collaborates with Asian and international programs of geoscience.

3. Seismological research: The Institute contributes to the national monitoring and research programs for the prediction of earthquakes, and characterize their features for the prevention and mitigation of disasters. The current research emphasizes the study of the fracture processes using rock-fracturing experiments in the laboratory, field observation by using seismic waves and short-term earthquake prediction by monitoring the groundwater.
4. Volcanic and magmatic research: We conduct geologic mapping of active volcanoes and related research to help understand the formation process of volcanoes, cause of eruptions, generation of magma and transportation of eruption products.
5. Geophysical research: Our mission is to develop various techniques for the precise imaging of the earth's subsurface structure, and research the crustal dynamics by using the above mentioned techniques. The results are provided on gravity and geomagnetic anomaly maps, and other geophysical maps.
6. Geochemical research: One of the main missions is the research on the chemical process and behavior of elements and isotopes including organic matter on the earth and in the solar system. Advanced analytical techniques are used for radiometric age determination of rocks and minerals, and to provide chronological data for geologic materials. Another important mission is the preparation and worldwide distribution of reliable geochemical reference samples

5.4. Institute for Geo-Resources and the Environment

As a major consumer, Japan accepts a major responsibility to develop minerals and energy resources in an efficient and environmentally sustainable way. This way achieves a good quality of life for the population and sustains industry activities in the country. As part of the industry technology development strategy, research activity related to the sustainable supply and development of minerals and energy resources is one of the priority areas of the Japanese government.

The Institute is also paying attention to the technology development related to the recycling and disposal of metals in an environmentally friendly way due to the needs of the society. Basic research and technology development as an intellectual infrastructure is also the responsibility of this Institution.

The mission of the Institute is to undertake research and technology development for: (a) promotion of safety and stable supply of geothermal energy and fuel and mineral resources; and (b) development and utilization of the earth's mineral resources in a environmentally sustainable manner (c) mine safety and health issues. The following themes are the priority fields of the Institute based on the needs from the society:

1. Development of technology for geothermal reservoir evaluation and management: Development of reservoir monitoring techniques and its associated mathematical modeling technology (history matching) involving geophysical survey techniques. As a long-term objective, it also aims to develop technology useful for geothermal reservoir enhancement.
2. Potential evaluation of coal bed methane /gas hydrate resources: (i) coal bed methane – geological, geochemical and geophysical studies on the formation of coal bed methane accumulations; and (ii) gas hydrate resources – analysis and evaluation of gas hydrate and other new type hydrocarbon accumulations.
3. Development of exploration methodology for large-scale blind hydrothermal deposits: Characterization of mineral deposits related to large-scale igneous intrusions and the development of their exploration strategy.

4. Technical cooperation for mineral resources development in Southeast and East Asia: (i) small-scale geothermal energy development on small islands in the Pacific region, especially in Indonesia, and (ii) implementation of a technical cooperation project in Vietnam on mineral resources assessment.
5. Development of information database in terms of resources and the environment: (i) modeling and evaluation of unused geothermal; (ii) development of fuel minerals distribution map and its database; (iii) compilation of mineral resources as a database; (iv) compilation of hydrogeology and environment data; and (v) compilation of geo-pollution.
6. Assessment and monitoring of ground utilization and development: (i) deep crust survey and its stress; and (ii) system development for geo-environment monitoring.
7. Geological and biological approaches for surveying contaminated sites: studies on heavy metal adsorption and fixation mechanisms by mineralogical and microbiological processes in earth surface environment

5.5. The Institute for Marine Resources and Environment

The Institute for Marine Resources and Environment (MRE) of AIST has a mission to develop industrial science and technology and provide geological information through its surveys. MRE engages survey and research, and technical development for providing marine geoscience information, investigation and utilization of marine resources, environmental mitigation and remediation, and protection against natural disasters. It uses a multi-disciplinary and/or trans-disciplinary approach “to understand, utilize wisely, and preserve the ocean and its environment”. The MRE provides the scientific foundation for the long-term strategy on Japan's ocean through research and development activities.

The institute conducts the following investigative and developmental activities to pursue its objective above by 14 research groups located at Tsukuba, Chugoku and Shikoku Centers.

1. Basic marine research: Scientific research on marine geology, environment and resources, contributing to understand nature and dynamics of marine system. The information will be displayed on various kinds of maps and in databases.
2. Effective utilization of marine resources: Research on technological development and application of mineral resources, marine energy resources, seawater, dissolved components in seawater, and marine-biomass.
3. Marine-related technology: Technological development and maintenance of marine structure and new materials usable under severe marine environments.
4. Utilization of ecological function of marine organisms: Research on marine organisms for environmental bioremediation in polluted areas and on utilization of marine bioresources.
5. Mitigation and renovation of coastal marine environments: Research and development of mitigation, restoration and renovation methods of coastal marine environments and establishment of total administration system of coastal area.
6. Research of global environments: Research of modern and past ocean environments, focusing on global and regional environmental issues, such as global warming and sea level change aiming at an assessment of environmental change in the future.

The MRE’s goals are symbolically summarized marine-trinity, that is, Information (scientific knowledge and expertise), Environment and Resources. Former research bodies of MRE performed programs individually or cooperatively in part to achieve each own goals similar the marine-trinity. Re-organization and Unification of institutes of AIST has brought a wide range of possibility on multi/trans-disciplinary research programs for sustainable development. Based on the understanding of geo-history and global to local phenomena in nature and with the interactions of human activities with natural systems, MRE provides marine science and technology for the nation to sustain the quality of life and to maintain and enhance fundamentals of economic strength. MRE is certain that the international co-operation and collaboration are important keys for sustainable development, and wishes to occupy the one of hubs in the international relationship.

Finally, MRE would like to mention that MRE will change more and more for achieving the goals and contributing sustainable development, and for the pursuit of possibility of geoscience organizations.

5.6. Geoinformation Division

Geoinformation Division provides reliable and impartial geoinformation for the public brought through the Geological Survey of Japan/AIST. Geoinformation Division belongs to the Public Relations Department of AIST.

Current Activities

In order to enhance works and services of GSJ, the division is responsible for the following functions.

1: GSJ's secretariat function: The division (1) works as an organizational hub of the GSJ, (2) promotes research cooperation committees and administrative committees in the GSJ, (3) works as a liaison office for related organizations in Japan, and (4) takes a quick information gathering and releasing when the urgent geologic hazard happens in Japan to take measures.

2: Geodata infrastructure: The following works are performed to establish the data infrastructure and standardizations.

- The acquisition of bibliographic geodata through the publication exchange in Japan as well as in international geoscientific organizations.
- Construction and the maintenance of GEOLIS (the Geological Literature Search System), and G-MAPI (Searchable system for geological maps in Japan and the world).
- Digitizing information of geoscientific maps and reports published by the GSJ.
- Support of constructing geoscientific databases for the research groups.
- Provisional service of geological metadata through the national spatial data clearinghouse of the central government
- Monitoring with precision measurements of geographical changes of hazardous active volcanoes.

3: Dissemination of geoinformation: The division disseminates the information in the following manners.

- Drawing maps and the printing with the explanatory papers introduced from the research groups.
- Editing with proofreading and the printing of research reports introduced from research groups.
- Publication of CD-ROMs of digitized geological maps and geoscientific data.
- Cooperation to edit 'Chishitsu News' : a geological magazine for public relations.
- On demand publication services of geological map printing and CD copying if there is no way of available maps and CDs in stock.
- Consolidating the Internet dissemination: maintenance of GSJ Homepages to disseminate useful information and research outputs such as digital maps, databases, research reports, observation data of active volcanoes and so on.
- Promoting events and exhibitions in geosciences in cooperation with the Geological Museum.
- Consolidating liaison functions with geological consultant companies of private sector, academia and local governments.

Future Vision

Establishment of geological standards

We recognize that geological maps in 1:50,000 scale reflect Japanese geological standards on classification of geologic time, stratigraphy and rocks. GSJ is now applying to

JIS (Japanese Industrial Standard) for ‘Cartographic standard for geological map symbolization’. The standards authorized by JIS will contribute to establishment of geological standards in Japanese academia and related companies. At the same time, CCOP geological organizations may consider ISO applicable to Asian geology.

Construction of CCOP geoinformation network

Nowadays, NSDI (National Spatial Data Infrastructure) becomes very popular in the world. GEIXS in Europe are typical examples of the regional network. The SANGIS technical workshop held in Bangkok triggered our demand of construction of CCOP geoinformation network. Geoinformation exchanges in CCOP region using recent IT will cope with the common geological problems such as environment, geohazards, urban problems, mining, etc. GSJ will support the construction of a clearinghouse among the geological organizations in CCOP region. It deals with GIS related metadata given by the organizations and disseminates useful geoinformation to CCOP nations.

Seamless geological maps

This is one of GSJ’s future subjects. Seamless geological maps operated in GIS are very useful and convenient uniformed maps for abstracting any area and synthesizing secondary outputs according to purposes. GSJ has a plan to make seamless geological maps at the scale of 1:200,000 covering the whole land until 2010.

E-commerce and mobile geomap services

Introduction of downloadable digital maps and databases for the public via Internet is also GSJ’s strategy in future. E-commerce will work for more effective dissemination of research products to the public. Mobile instruments are powerful tools to acquire field data and disseminate information. Recently the number of subscribers of cellular phones are rapidly increasing in Japan. Such mobile tools with W-CDMA technique and cheap packet data transmission will be utilized for geoscientific fields in the coming generation.

Geological guide maps for the public

Geological maps are published not only for geological specialists but also for public use. GSJ published the CD-ROM of ‘Geological Guide of Hokkaido’ by way of trial this year. It has a little bit public responses. The following issue of this kind of CD-ROM about main land is expected by the public.

5.7. Geological Museum

The Geological Museum plays a unique role as the only museum in geosciences in Japan that makes educational and informational contribution to the society through the exhibitions on the progresses of research at the "Geological Survey" in the National Institute of Advanced Industrial Science and Technology (AIST) such as the most up-to-date information on geology of Japan and surrounding areas, natural resources, earthquakes, and volcanic eruptions. People who visit the museum can understand important issues such as conservation of our environments and prevention of natural disasters and can get keys to understand how we can live with our earth.

The core of the activities of the Geological Museum is the permanent exhibition and the storage of geological specimens. The displays of the world-class specimens of rocks, minerals, and fossils, supported by explanations by color plates and schematic models, are the most important in all the exhibition rooms. More than 120,000 specimens of rocks, minerals, and fossils that have been registered and stored in the storage will be studied as research materials by scientists not only of geosciences but of chemistry, physics, biology, and medical sciences and have been utilized for the journalistic and educational purposes by the press, the publishers, elementary schools, junior and senior high schools, and other regional and local museums. The data on all the registered specimens are now stored in the computer - controlled database system.

In addition to the permanent exhibition, special exhibitions are presented several times a year. The special exhibitions include up-to-date topics in geosciences related to the progresses in research activities at the "Geological Survey". Themes of recent special exhibitions are: “the World of Quartz Crystals (2000)”, “Volcanic Eruptions in 2000, Mt. Usu and Mt. Miyake-jima (2000)”, “Hot Springs under Deep Sea (2000)”, “Western Tottori Earthquake on Oct. 6, 2000 (2001)” , and “The Sea, Its Resources and Environments (2001)”.

Special events such as consultation for school children, cleaning of fossil plants, making of fossil replica models, mineral identification quiz, and crystal hunting are occasionally held. Consultation for school children is held for 1 whole day near the end of every August and researchers in the museum help school children for identification of rocks, minerals and fossils that are collected by them during summer vacation. Although this consultation is primarily for school children, it is also open to anyone. Except for that day, consultation is available by appointment.

The Geological Museum has had international cooperation programs with museums on geosciences of all over the world, e.g., supervision on the exhibitions and specimens, and exchange and/or donation of specimens. This international program of the museum has been appreciated worldwide.

5.8. International Geoscience Cooperation Office

This office belongs to the International Affairs Department. Our office will actively contribute to improve the technical cooperation and promote international projects by collecting and analyzing information on international law, treaty, guideline and statements related to the geological missions

With the increasing demands for the solution of global issues such as environment, natural disaster, resources, energy, etc., the enhancement of the international research cooperation in the field of geoscience becomes more important and many international projects are being implemented.

Today the geological information is being globally used for environmental issues or assessment of resources and it is indispensable to provide various information of geology or geoscience for global information networks. For full dissemination of global information, related organizations are required to work together for standardization of information to make it widely used. The most efficient way for realization is to actively use the network of Geological Surveys located in about 150 countries.

Many Asian and/or other developing countries are expecting research or technical cooperation on the best practice management of mining, exploration, environmental protection and remediation. Japan is responsible for supporting sustainable development of those countries. We would like to support and make a contribution to them through international cooperative organizations like CCOP.

As a representative organization of Japan in the field of geoscience, our office will promote activities of the following international organizations; CCOP (Coordinating Committee for Coastal and Offshore Geoscience Programmes in East and Southeast Asia), ICOGS (International Consortium of Geological Surveys) as its board office for Asia/Pacific Regions, CGMW (Commission for the Geologic Map of the World) and ISTC (International Science and Technology Center in Moscow). Through these activities we will aim at globalization of the geoscience information and enhancement of cooperative relationship with Asia/Pacific and other Regions to solve problems on resource, environment, energy, natural disaster, etc.

Our office will play a core role for especially constructing an Asian network of the geoscience information for land/resource management, hazard mitigation and risk communication, which will also contribute to the construction of the world network.

DEFORMATION OF CONTINENTAL MARGIN OF NORTHEAST ASIA: TECTONICS AND GEODYNAMIC MODELING

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INTRODUCTION

The continental margins of East Asia were formed throughout a long-term evolution essentially determined by convergence with the Pacific-originated plates. Accretion of arc terranes and oceanic plateau represents one of the leading processes in formation of the margins. Collision of arc terranes with continental margins of East Asia occurred at different time along strike of the margins. This process is currently active in Southeast Asia (Fig. 1). In Northeast Asia, arc-continent collision was mostly typical in the Cenozoic and does not occur now. The new results on deformation of continental margin of Northeast Asia produced during the Cenozoic arc-continent collision in Kamchatka are discussed in this paper.

GEODYNAMIC SETTING OF KAMCHATKA IN NORTHEAST ASIA

The Kamchatka orogen is located in the frontal (facing to Pacific) part of the Northeast Asian margin (Fig. 1). Three accreted arc terranes were incorporated in the nappe-folded basement of Kamchatka during the Late Mesozoic - Cenozoic. As a result, the Mesozoic active margin of Northeast Asia shifted to the southeast. Three overlap volcanic-plutonic belts developed above the growing continental margin in Kamchatka during the Cenozoic: Koryak - Kamchatka (Middle Eocene-Oligocene), Central Kamchatka (Oligocene-Quaternary) and Eastern Kamchatka (Pliocene-today) belts (Shantzer et al., 1985; Filatova, 1988).
The Mesozoic active margin of Northeast Asia is marked by the Okhotsk-Chukotka belt developed during the Albian - Campanian (Filatova, 1988). The region of Sea of Okhotsk between the Mesozoic active margin of Northeast Asia and Kamchatka orogen is underlain by the Okhotsk microplate lithosphere (Fig. 2) that contains several suboceanic or subcontinental blocks (Kharakhinov et al., 1996). The microplate moves slowly to the northwest relative to Eurasia and North America (DeMets, 1992; Seno et al., 1996; Takahashi et al., 1999). Recent tomographic data of Bijwaard et al. (1998) and Gorbatov et al. (2000) reveal the positive velocity perturbation feature beneath the northern Sea of Okhotsk. This high-velocity anomaly extending to ~660 km of depth and then deflecting along the 660-km discontinuity was interpreted as a remnant slab of the Okhotsk microplate (Fig. 2) (Gorbatov et al., 2000). The microplate is estimated to be docked against the Asian continent at ~55-65 Ma (Zonenshain et al., 1990; Kimura, 1994; Worrall et al., 1996), thus, since that time forming the frontal margin of Northeast Asia.
The Kamchatka orogen contains three accreted oceanic arc terranes and the Sredinny microcontinent (Fig. 1). West of Kamchatka, the orogen is composed of remnants of the Kvakhona metamorphosed arc (Jurassic - Lower Cretaceous) and the Sredinny microcontinent (Fig. 2) (Bondarenko and Sokolkov, 1990; Bondarenko, 1992; Rikhter, 1995). These structures formed the southeastern (facing the Pacific) accretionary boundary of the Okhotsk microplate since the Middle - Late Cretaceous. Within the central and eastern Kamchatka (Fig. 2), the orogen contains two arc terranes, so-called Achaivayam-Valaginskaya (Campanian - Lower Paleocene) and Kronotskaya (Coniacian - Eocene) arcs.

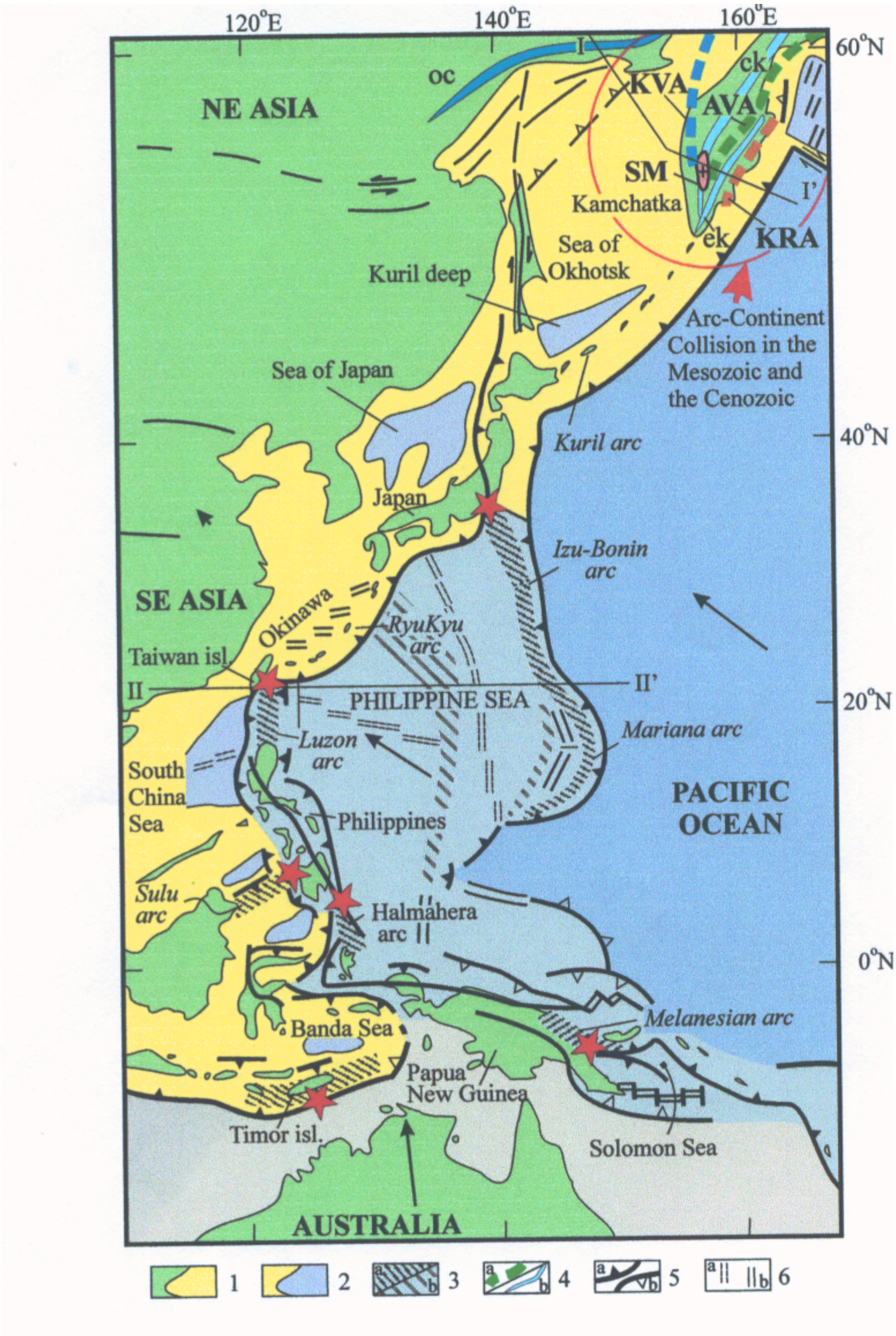

Figure 1. Geodynamics of convergent boundaries along continental margins of East Asia. Modified after (Lallemand, 1999). Stars show location of currently active arc-continent collision along the margins of Southeast Asia. Black arrows show absolute plate motion. Cross-sections along lines I-I' and II-II' are shown in Fig. 2 and Fig. 9, respectively. 1 = continental margin of East Asia, underwent an extension in the Cenozoic, 2 = Cenozoic oceanic basins in margin of East Asia; 3 = volcanic arcs active (a), inactive (b); 4 = accreted arc terranes (a), overlap volcanic-plutonic belts (b); 5 = subduction zones active (a), inactive (b); 6 = spreading zones active (a), inactive (b). In letters: volcanic-plutonic belts = Okhotsk-Chukotka (oc), Central Kamchatka (ck), Eastern Kamchatka (ek); arc terranes = Kvakhona (KVA), Achaivayam-Valaginskaya (AVA), Kronotskaya (KRA); Sredinny microcontinent (SM).

The arcs are intraoceanic, originated in Northwest Pacific, that is supported by both geochemical (Khubunaya, 1987; Konstantinovskaya, 1992; Magakyan et al., 1993; Kamenetskiy et al., 1993) and paleomagnetic (Bazhenov et al., 1992; Pechersky et al., 1997; Shapiro et al., 1997; Levachova, 1999; Kovalenko, 2000) data. The Achaivayam-Valaginskaya and Kronotskaya arcs were incorporated in the Kamchatka orogen during the Early Eocene and at the end of the Miocene, respectively. In the present structure of the orogen, the arcs are separated by a suture zone that contains deformed slices of young (Paleocene - Lower Eocene) oceanic crust of the Vetlovka intraarc basin (Fig. 2).

TECTONIC STRUCTURE OF SOUTHERN KAMCHATKA

The tectonic structures of Southern Kamchatka represent an example of syncollisional deformation of continental margin formed during the Early Eocene collision of the Achaivayam-Valaginskaya arc with the Sredinny microcontinent.

The Sredinny microcontinental block of Southern Kamchatka (Fig. 3a) contains granulite facies rocks intruded by plagiogranites dated by the Rb/Sr methods as 127 ± 6 Ma (Vinogradov et al., 1988; 1991; Rikhter, 1995). The Sm/Nd isotopic dating of the granulite facies rocks allows to suggest the age of the protolith as old as 950 Ma to~1 Ga (Kuz'min and Belyatsky, 1999). The Rb/Sr and K/Ar dating of the Sredinny block rocks reveal several metamorphic events, the later one is dated as young as about 50-60 Ma (Chechovich, 2000) that corresponds to the time of the Early Eocene collision of the block with the Achaivayam-Valaginskaya arc.

Remnants of the Kvakhona arc tectonically emplaced along the western margin of the Sredinny block at the end of the Early Cretaceous (Fig. 3a) (Bondarenko, 1992). The arc and the metamorphic block are overlain by continental-derived turbidites of Middle-Late Cretaceous age. The Malkin terrane thrust to the west over the granulite basement of the Sredinny block along its eastern margin and in the periclinal zones before the Campanian (Fig. 3a). The Malkin terrane is composed of the amphibolite-facies metamorphic rocks that are recognized as originally arc-related volcanites (Rikhter, 1995). The non-metamorphosed molasse deposits of Campanian and Paleocene ages unconformably overlie the Malkin terrane and contain redeposited clastics of the metamorphic rocks (Shapiro et al., 1986; Slyadnev et al., 1997).

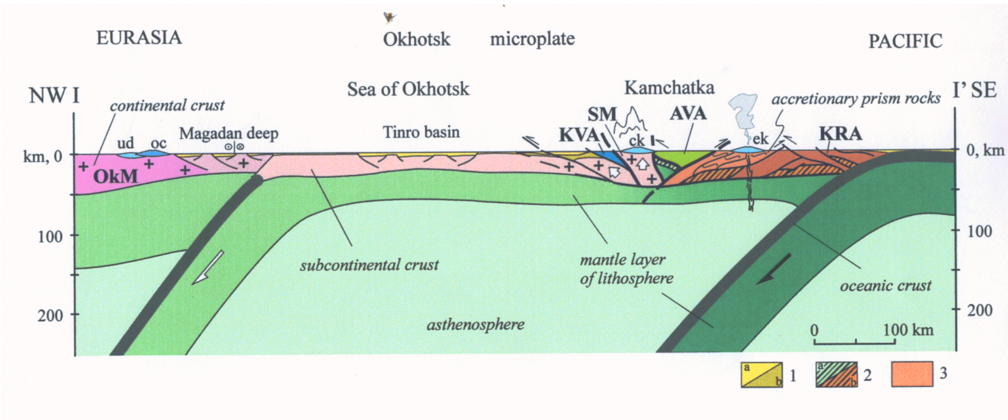

Figure 2. Simplified cross-section locating in Fig. 1 of Northeast Sea of Okhotsk and Kamchatka. Data on type and thickness of crust are taken from Kharakhinov et al. (1996). Subduction zones of the Okhotsk microplate and the Pacific plate are shown after Gorbatov et al. (2000). Black and white arrows indicate active and inactive subduction, respectively. In letters: Uda-Murgal volcanic-plutonic belt (ud); Okhotsk microcontinent (OkM). Other key symbols as in Fig. 1. 1 = Cenozoic (a) and Cretaceous (b) sedimentary units; 2 = oceanic basement of AVA (a) and KRA (b); 3 = oceanic crustal unit of Vetlovka intraarc basin.

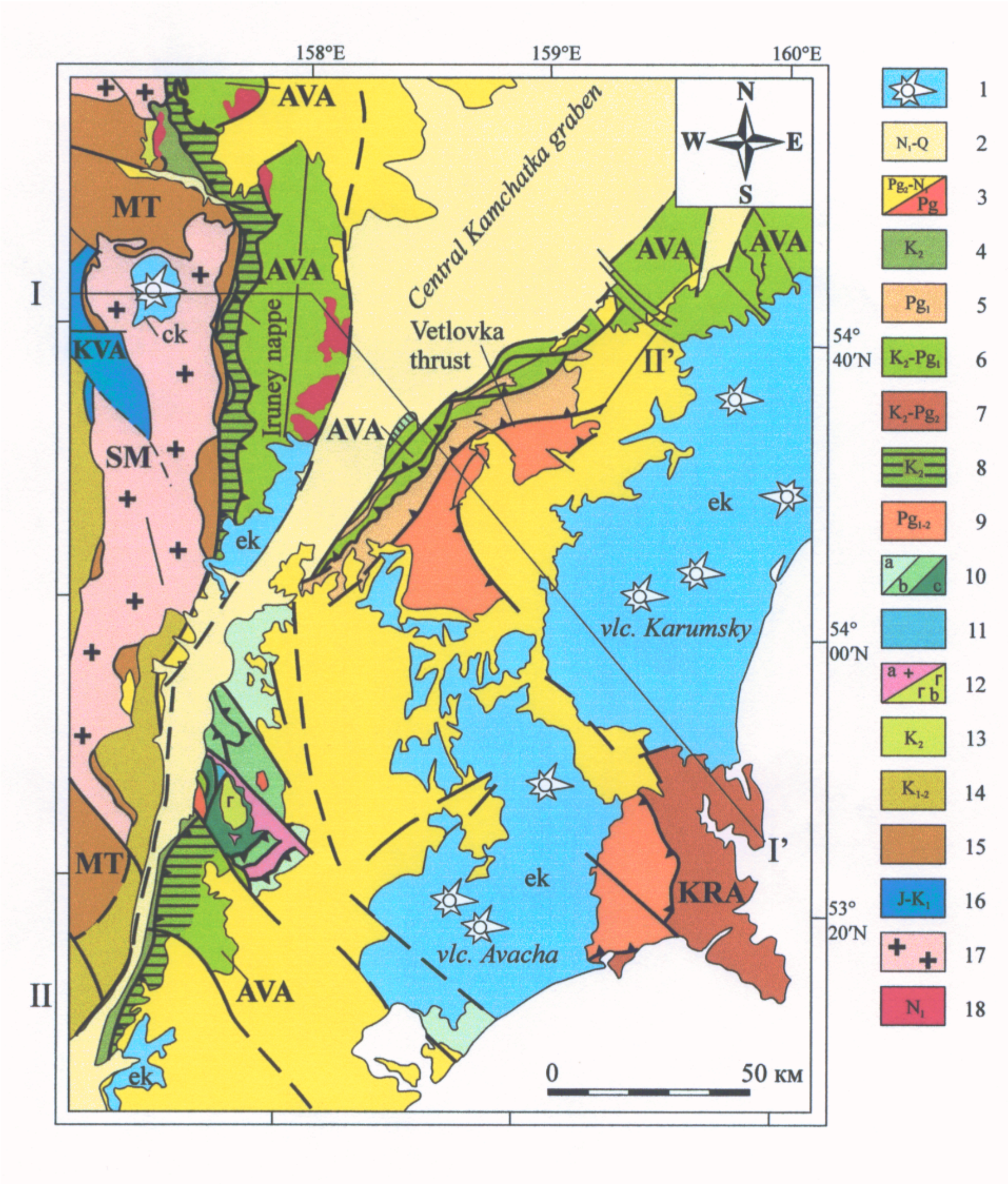

Figure 3a. Tectonic map of Southern Kamchatka. Cross-section along line I-I' is shown in Fig. 3b. 1-3 = overlap volcanic (1) and sedimentary (2-3) units; 4-9 = allochthonous units: 4-5 = continent-derived turbidites; 6 = Achaivayam-Valaginskaya (AVA) arc; 7 = Kronotskaya (KRA) arc; 8-9 = oceanic crustal units of Iruney (IB) marginal basin (8) and Vetlovka (VB) intraarc basin (9); 10-12 = Ganalsky syncollisional metamorphic core; 13-17 = Sredinny microcontinent: 13-14 = molasse (13) and turbidites (14); 15-16 = metamorphosed arc terranes Malkin (MT) (15) and Kvachona (16); 17 = granulite basement; 18 = granites. Horizontal hatched pattern on the map is vertical on the cross section. Other symbols as in Figs. 1, 2.

The relic structures of the Achaivayam-Valaginskaya arc form the Iruney nappe thrusting to the west over the margin of the Sredinny microcontinent (Fig. 3a). The leading edge of the arc is underlain by fragments of Upper Cretaceous oceanic crust (Fig. 3b), ca. Iruney marginal sea unit (Konstantinovskaya, 1997). The eastern margin of the Achaivayam-Valaginskaya arc is marked by the Vetlovka thrust (Fig. 3a). Along this fault, the arc emplaced to the southeast over Paleocene - Early Eocene oceanic unit, ca. Vetlovka intraarc basin unit (Fedorchuk et al., 1990). Both these thrusting events to the west and to the southeast occurred along the western and eastern edges of the arc, respectively, are dated by the Early Eocene (Bakhteev et al., 1994; Konstantinovskaia, 2000). The Vetlovka oceanic unit thrust over the Upper Eocene - Upper Miocene sedimentary units exposed to the east in the Grechishkin collisional suture (Fig. 3b). The suture bounds the Kronotskaya arc from the west along its extension at ~300 km (Fig. 1). Within the suture, a system of steep northwest-dipping synsedimentary thrusts (Fig. 3b) developed in terrigenous deposits during the Late Eocene to terminal Miocene, when the Kronotskaya arc docked to Kamchatka (Bakhteev et al., 1997).

GEODYNAMIC MODEL OF KAMCHATKA ARC-CONTINENT COLLISION

The model concerns the Early Eocene collision of the Achaivayam-Valaginskaya arc with the Sredinny microcontinent of the Asian continental margin affinity. The model is based both on the analysis of geological data from Kamchatka and on the results of the 2-D experimental physical modeling of arc-continent collision. From geology of Kamchatka, it is known that since the Middle-Late Cretaceous tectonic structure of the Sredinny microcontinent was heterogeneous and contained previously accreted and metamorphosed Kvakhona and Malkin arc terranes (Fig. 3b). The heterogeneous, accretionary continental margin may be simulated in the experiment taking into account the lowered strength of crustal layer of continental margin. The new experiments of 2-D physical modeling of arc-continent collision adopting the continental margin with a crustal layer of the lowered strength are recently realized (see more details in (Chemenda et al., in press)).

The results from the experiments reveal that the margin fails at the beginning of subduction before the major deformation in the overriding plate in the arc area occurs (Fig. 4). The subducted crustal slice is completely scarped from the mantle base, accreted to the forearc block, and becomes part of this block (Fig. 4c). After some subduction of the continental margin, the overriding plate fails in the arc area along the east-dipping fault, which results in subduction of the forearc block (Fig. 4d-e). At stage (f), crust of the margin fails along the two conjugated faults, which separate an uplifting crustal wedge. Uplift of this wedge causes a failure in the frontal part of the overriding plate and a formation of a backthrust (Fig. 4f). Fig. 4g shows the formation of one more crustal thrust. Thrusting and thickening of the subducting crust causes an uplift of the frontal part of the forearc block and formation of the ridge (Fig. 4g-h). At the end of the experiment, the accreted crustal slices in the continental margin form a large orogenic area with the relief up to 9 km in front of the overriding plate (Fig. 5).

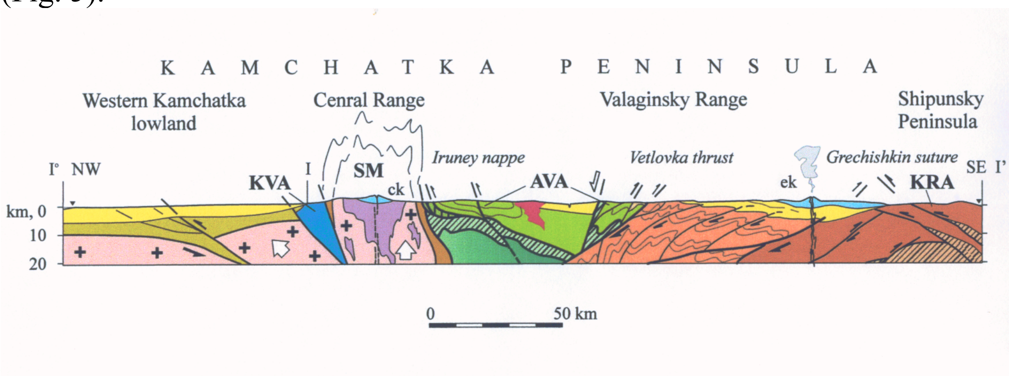

Figure 3b. Cross-section across Southern Kamchatka. Location of the cross-section I-I' is shown in Fig. 3a. Coastal line is marked by black triangles. Key symbols as in Figs. 2, 3a.

Both the analysis of the geological data and the results from 2-D experimental modeling of arc-continent collision allow to distinguish the following major stages in this process in Southern Kamchatka (Fig. 6) (Konstantinovskaia, 2000). At the beginning of subduction of the Asian continental margin at ~60 Ma, failure and thickening of the subducting crust of the margin occur under the frontal part (accretionary prism) of the overriding Vetlovka plate (Fig. 6b). During the following steps, uplift (squeezing) and exhumation of the subducted crustal

Figure 4. Successive stages of the model deformation in cross-section (experimental photos). The lines had drawn in Figs. 4c-h correspond to the faults in the crust. See more explanations in the text.

slice of the continental margin result in initiation of the Sredinny Range at ~50 Ma (Fig. 6c-d). Flexural buckling (subsidence) of the Achaivayam-Valaginskaya arc/forearc under strong horizontal compression leads to sedimentary infilling of this area by the material shed from the growing and deformed accretionary prism (Fig. 6b). Failure of the Vetlovka plate along the west-vergent fault dipping beneath the arc is finished in collapse (closure) of the forearc and complete subduction of the forearc block (Fig. 6c). Stoppage of continental subduction and subduction reversal result in the onset of the Vetlovka oceanic plate subduction and tectonic accretion of the oceanic crustal rocks (basalts and pelagic sediments) to the eastern side of the Achaivayam-Valaginskaya arc (Fig. 6d). Further evolution of the new oceanic subduction followed by detachment of the previously subducted plate, formation of the Central Kamchatka volcanic belt and of growing accretionary prism (Grechishkin suture) to the east from the belt (Fig. 6e).

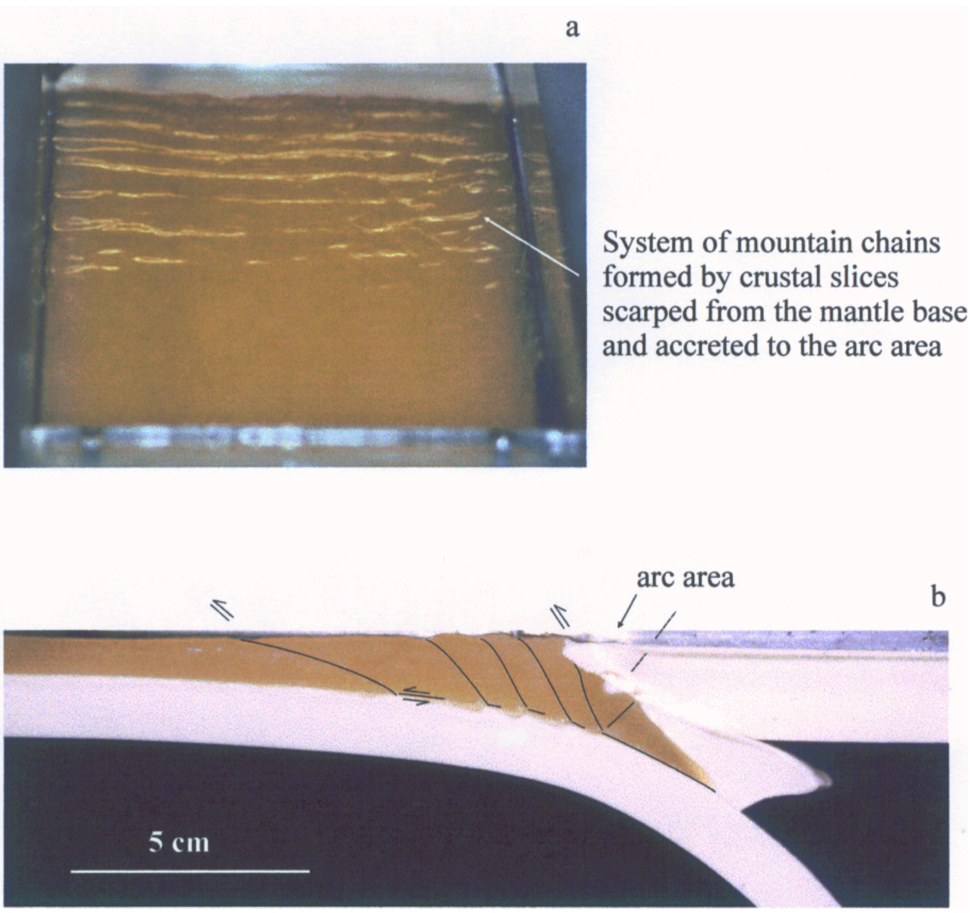

Figure 5. The final stage of the model deformation in plan view (a) and in cross-section (b) of the experiment shown in Fig. 4 (experimental photos). The lines had drawn in Fig. 5b correspond to the faults in the crust. See more explanations in the text.

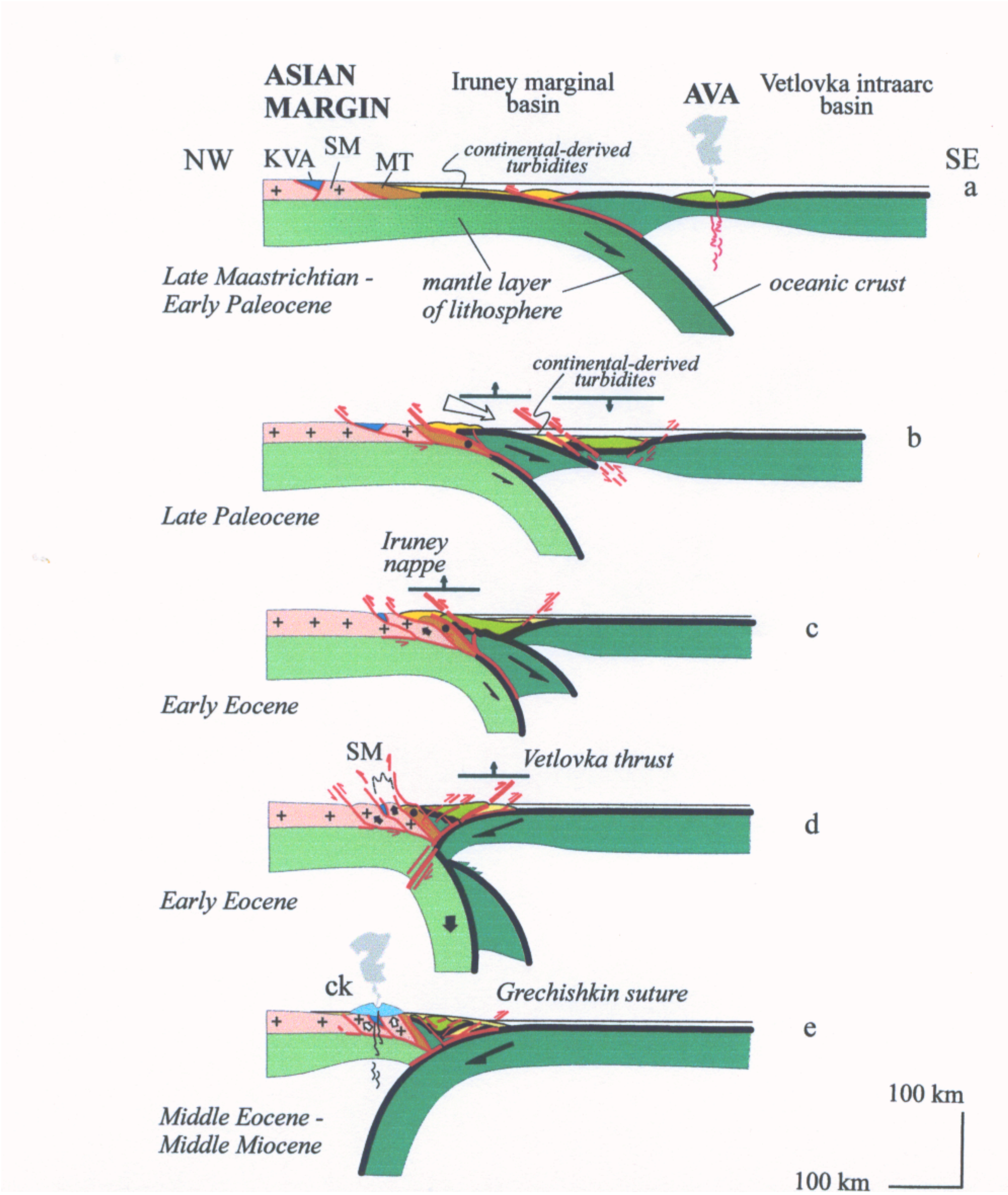

Figure 6. Geodynamic model of the Southern Kamchatka arc-continent collision. Key symbols as in Figs. 1, 2. White arrow on profile b indicates erosion and redeposition of continental-derived turbidites from rising accretionary prism of fore-arc block in the area of arc subsidence.

GEODYNAMIC SETTING OF KAMCHATKA ARC-CONTINENT COLLISION IN THE CENOZOIC EVOLUTION IN NORTHWEST PACIFIC

The continent-ocean transition zone in the Northwest Pacific in the Early Cenozoic was composed of the following structures (Fig. 7): continent - Okhotsk microplate - marginal oceanic basin - inner arc - intraarc oceanic basin - outer arc - ocean (Konstantinovskaia, 2000; 2001). The inner and outer arcs were formed above the subduction zones both dipping toward the intraarc oceanic basin (Fig. 7a). The relative motion of the arcs one from another lead to extension and spreading in the intraarc basin with formation of the Paleogene oceanic crust (Fig. 7b) that currently is found in the suture zone between the two arc terranes in Kamchatka. Closing of the marginal oceanic basin resulted in collision of the inner arc with the continental margin (Fig. 7b-c). The collision process propagated northeastwards along strike of the collided arc and followed by subduction reversal (Fig. 8). The onset of oceanic subduction of the intraarc plate under the new formed accretionary margin resulted in the northwestward migration of the outer arc to the continental margin and finally - in the arc-arc collision (Fig. 7d-f). After that, at ~5 Ma, the recent configuration of the Northeast Asia margin was established (Fig. 7g).

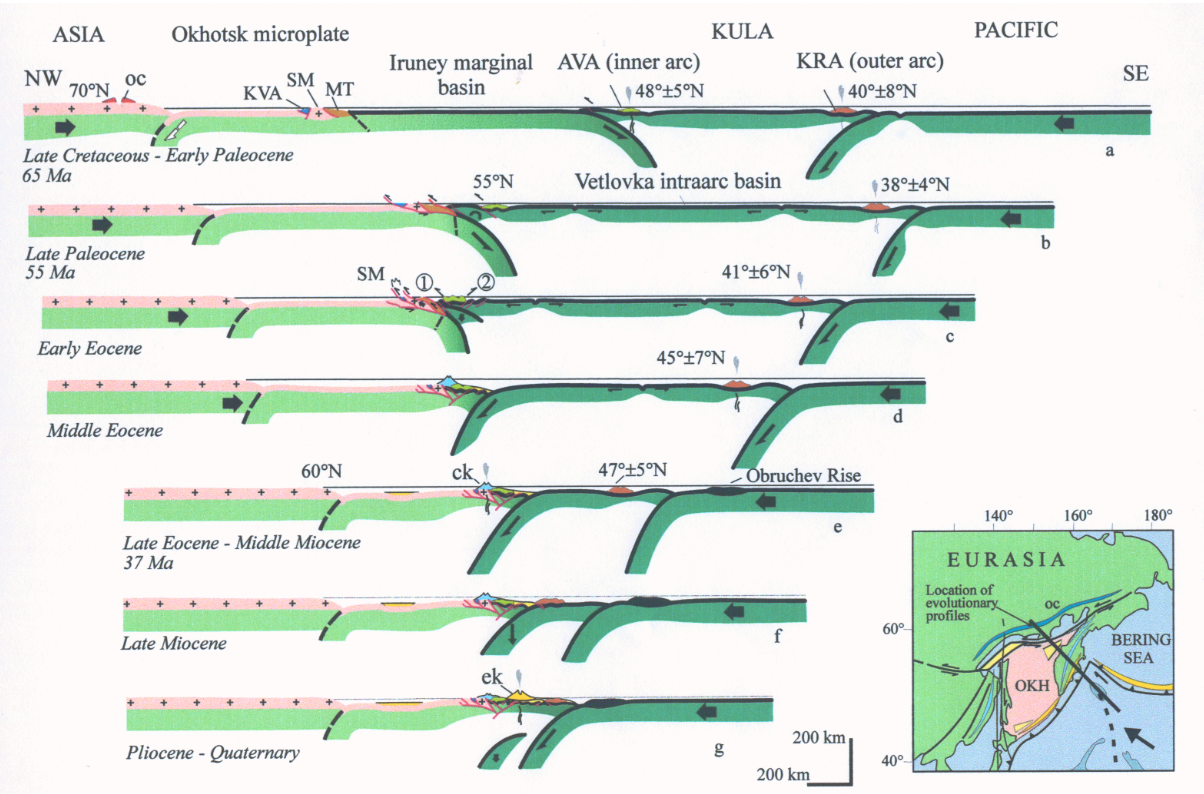

Figure 7. Synthetic cross-section of the Asian continental margin in Northwest Pacific (the most lower profile) and an evolution model in several steps. Location of the evolutionary profiles is shown in the inset. The paleomagnetic data are taken from (Bazhenov et al., 1992; Pechersky et al., 1997; Shapiro et al., 1997; Levachova, 1999; Kovalenko, 2000). In letters: OKH = Okhotsk microplate. In Fig. 7c: 1 = Iruney nappe; 2 = Vetlovka thrust.

DISCUSSION

The discussed above geodynamics and tectonic evolution of Northeast Asia in the Cenozoic is similar to the current geodynamics of Southeast Asia. Continental margin of Southeast Asia is structurally heterogeneous and contains microcontinent blocks and marginal oceanic basins formed during the Cenozoic extension of the margin (Fig. 1). The recent geodynamic evolution of the continental margin of Southeast Asia is characterized by closing of the marginal oceanic basins along the subduction zones dipping to the east and the southeast. The volcanic activity related to these zones occurred in the inner volcanic arcs of the Philippine Sea region (Luzon, Phillipines, Sulu, Halmahera arcs) (Fig. 9a-b). The progressive closing of the marginal oceanic basins results in collision of the inner arcs with the continental margin. The collision of the Halmahera arc with the Southeast Asian margin at ~4 Ma ago was followed by subduction reversal with the onset of subduction of the Philippine Sea plate under the margin along the Philippine trough (Pubellier and Cobbold, 1996; Pubellier et al., 1999; Lallemand et al., 1998).

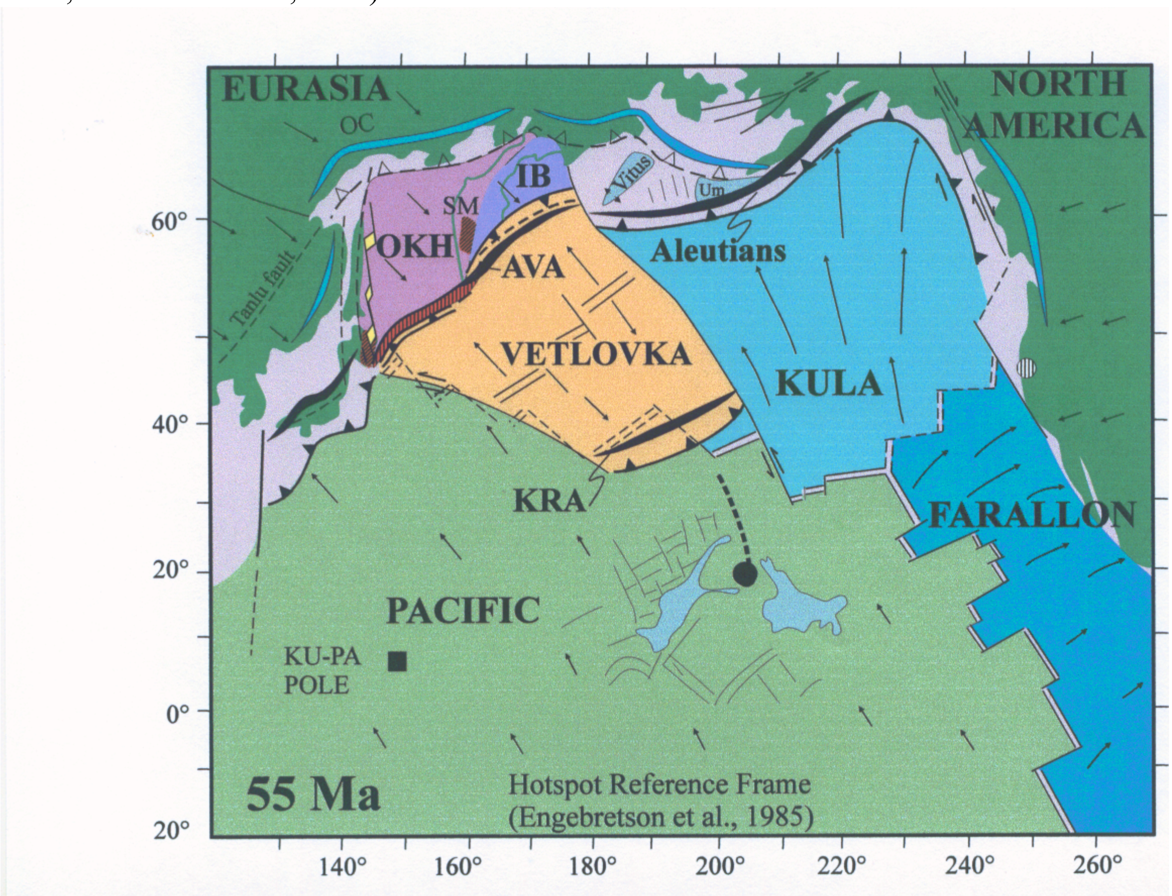

Figure 8. Reconstruction of continent – ocean boundary in Northwest Pacific at ~55 Ma. Keys distinguish zone of active volcanism (thick black line), inactive volcanic-plutonic belt (thick blue lines), deformed arc terrane (red hatched pattern). In letters: Um = Umnak oceanic plateau. Other symbols as in Figs. 1, 2, 7.

The collision of the northern segment of the Luzon arc with the Asian continental margin (Fig. 1) is suggested to result in the onset of subduction of the Philippine Sea plate dipping under the northern Taiwan orogen (Fig. 9c-e) (Malavieille, 1999; Teng et al., 2000; Lallemand et al., 2000). During the arc-continent collision, failure and thickening of the subducting crust of the Asian continental margin under the frontal part of the Philippine Sea Plate occurred since ~6-7 Ma, preceding deformation in the Luzon arc - forearc area (~3-4 Ma) and subduction reversal (Chemenda et al., in press). It is most likely that the subduction zones dipping to the west along the eastern sides of the Luzon arc in the north and the Philippine arc in the south (Fig. 1) may connect in time. If so, the Philippine Sea plate could be completely subducted under the Asian continental margin, and the scenario reconstructed for Kamchatka at ~50 Ma would be realized (Figs. 7d; 9e). The intraarc Philippine Sea basin would be closed and the outer Izu-Bonin-Mariana arc would be docked to the accretionary margin, resulting in the arc-arc collision (Konstantinovskaia, 2001).
Deformation of continental margin of Northeast Asia occurred during arc-continent collision is essentially determined by tectonic structure and strength of crustal layer of the margin. The continental crust of the subducted margin is characterized by a weak strength, and deformation occurs firstly within the margin. The crustal blocks are detached and accreted in front of the overriding plate preceding the deformation in the overriding plate within the arc area. This type of evolution is reconstructed at ~50 Ma in the Kamchatka area and occurs recently in the Taiwan area.

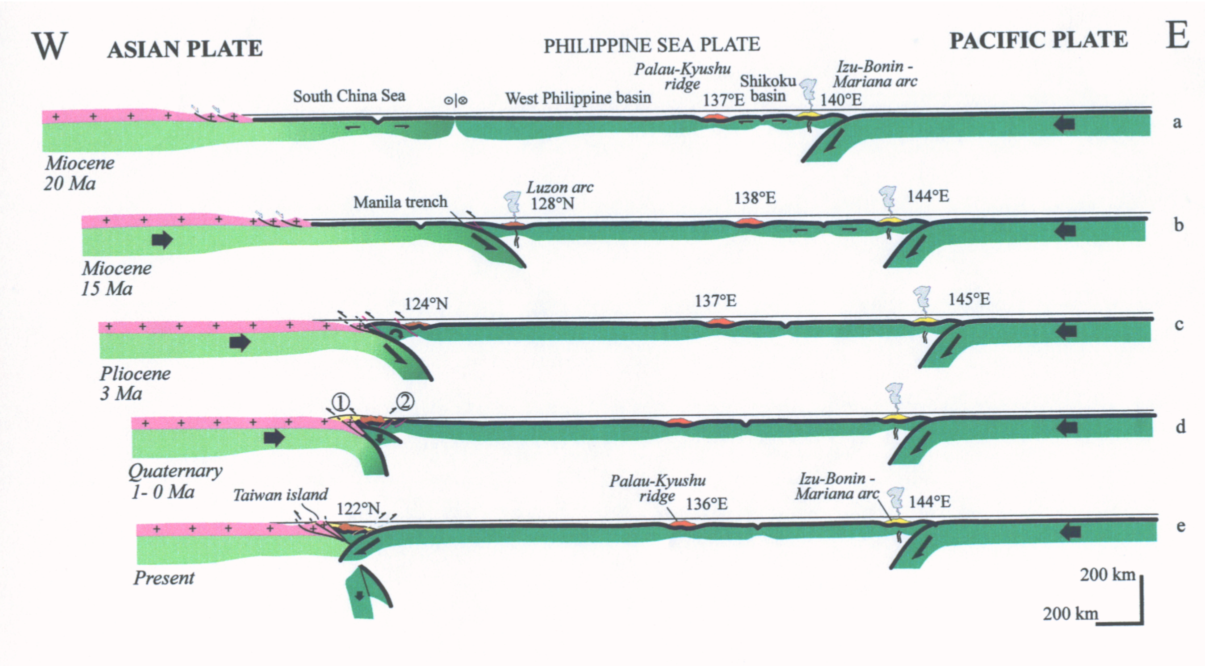

Figure 9. Synthetic cross-section locating in Fig. 1 of Southeast Asian continental margin and Philippine Sea (the most lower profile) and an evolution model in several steps. Based on data from (Rangin et al., 1990; Lallemand et al., 2000).

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