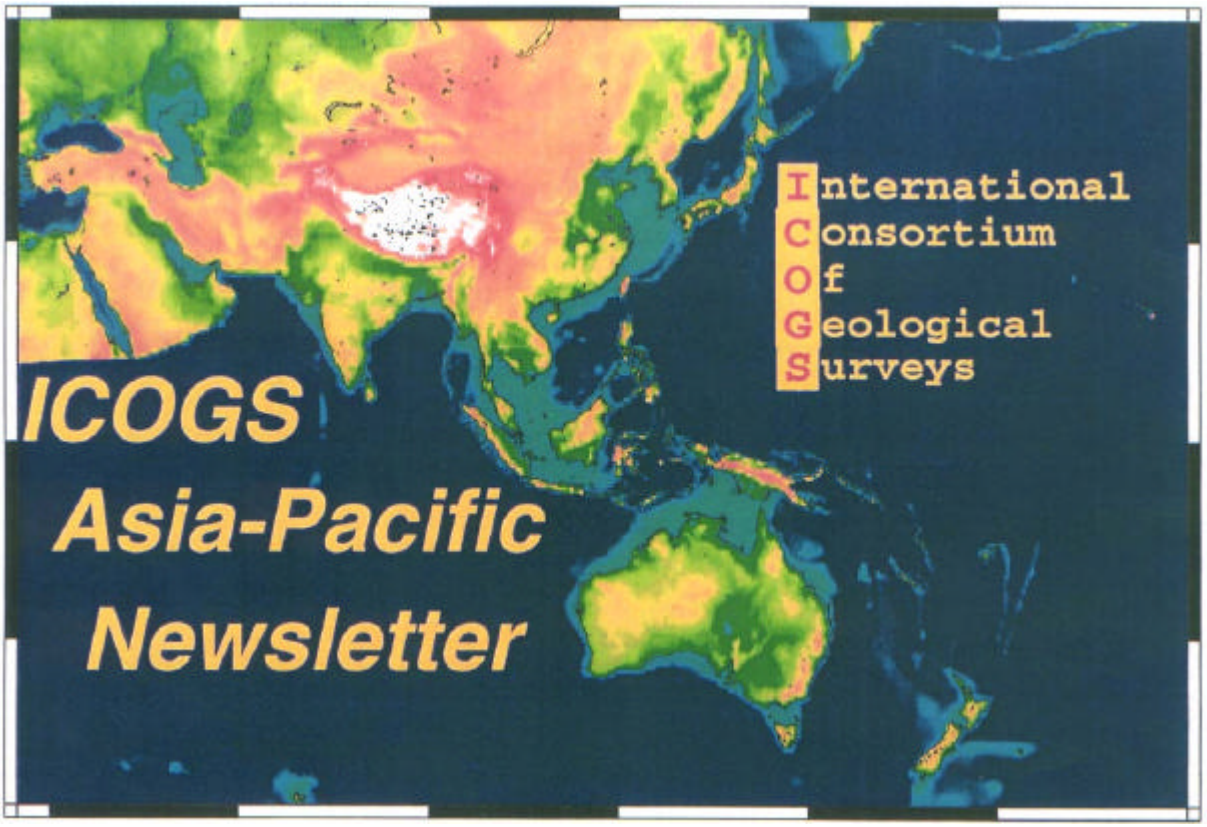

ICOGS ASIA-PACIFIC NEWSLETTER

No.3, October 2000

CONTENTS

The fourth edition of "Directory of Geoscience Organizations of the World" was published in March 2000, and one copy of the directory was distributed to each organization in the directory. More copies may be available from International Geology Office, Geological Survey of Japan. We would appreciate your comments on the directory. After correcting errors in the directory, we plan to publish the fifth edition in early 2001.

From ICOGS Secretary for Asia and the Pacific

It is our great pleasure to send you the third issue of the ICOGS Asia-Pacific Newsletter just before the beginning of the 21st Century.

We have received contributions to the third issue from three organizations. The Geological Survey Division, Department of Mineral Resources, Thailand sent us a recent brochure, which introduces their organization. An original article titled "Information about geology of the Kyrgyz Republic (Kyrgyzstan)" was submitted by the Institute of Geology, Academy of Sciences, Kyrgyzstan. A very comprehensive article titled "Status of the geological sector of Vietnam" was sent from the Department of Geology and Minerals of Vietnam.

We would like to express here our sincere thanks to the contributers of the above articles. We also tried to include an article to introduce a CD-ROM publication "Geotectonic map of East and Southeast Asia: Sheets 4, 5 and 6", which was recently published as CCOP Technical Bulletin, Vol. 27. Inclusion of all the above articles made this issue total of 40 pages. Hope this newsletter would be interesting and useful for you.

The second issue of the ICOGS Asia- Pacific Newsletter can be downloaded from our web-site(http://www.gsj.go.jp/PSV/Intl/index-e.html) now, and we also plan to make this issue available on the same web-site.

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. A short article such as news on recently published maps and other publications may 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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ICOGS Seminar on

Application of geoscience mapping and related geoscientific products in the 21st Century

This seminar was held in 15-16 August 2000 during the 31st International Geological Congress in Rio de Janeiro. About 15 presentations were made by participants from geological survey organizations in Europe, Australia, America, Asia and Africa, including the Australian Geological Survey Organisation, the Geological Survey of Western Australia, the Geological Survey of India, the China Geological Survey and the Geological Survey of Japan from the Asia-Pacific region. They introduced their recent and newly-implemented programmes and problems they are being faced with. Main activities of some geological survey organizations, especially in developing countries, are still focussed on mapping and basic data collections, while those of other organizations are now shifting to the management, dissemination and application of their geoscience knowledge to specific society's requirements. It was stressed in their talks that it is imortant to utilize Information Technology such as GIS, Internet (or the Web), and to meet the needs of various kinds of possible customers, who are often unaware of geoscience.
All the materials presented at the seminar were planned to be included in a CD-ROM. For more information on the seminar and the CD-ROM, please contact Dr. Gabor Gaál, Director, Research and Development, Geological Survey of Finland (e-mail: gaal@gsf.fi).

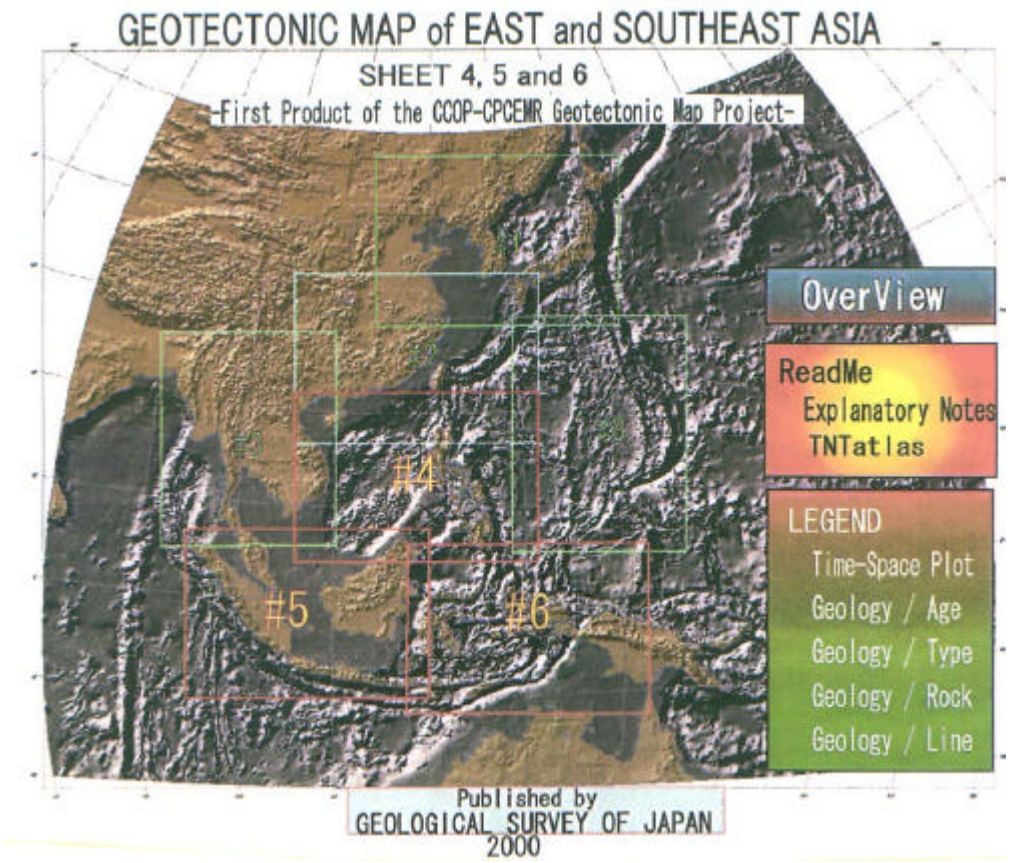


Figure 1. Home window of the Geotectonic Map of East and Southeast Asia CD-ROM showing the sheet areas. Digitized data for Sheets 4, 5 and 6 are included in this CD-ROM. Those for Sheets 1, 2, 3 and 8 will be included in the second CD-ROM, which will be published in the near future.

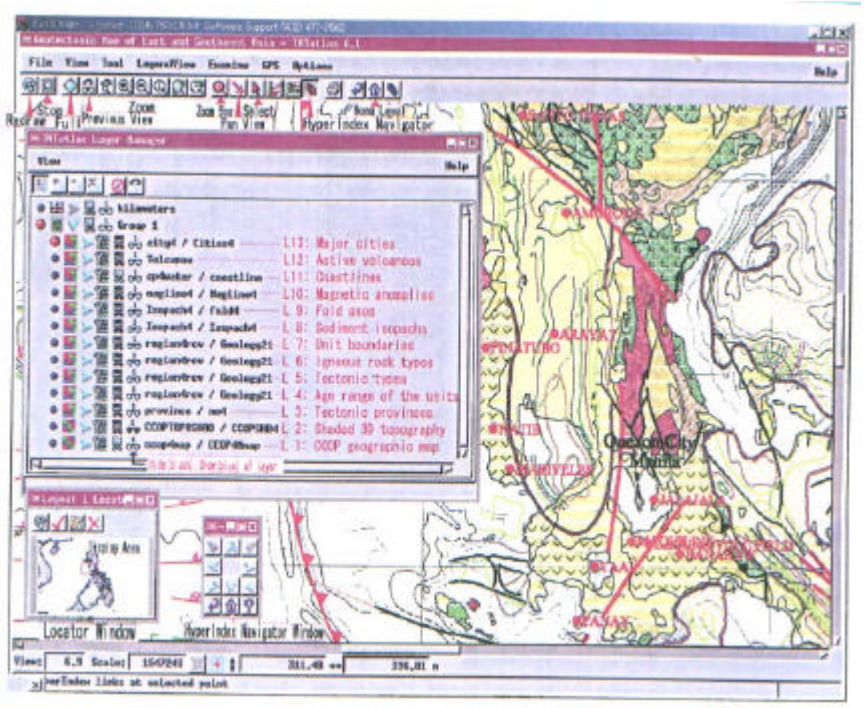


Figure 2. An example of the map seen on the screen. Each of the thirteen layers can be selected on the Layer Manager window.

A dgital data CD-ROM of East and Southeast Asia Geotectonic Map was recently published as CCOP Technical Bulletin Vol. 27, and is now available from the CCOP Technical Secretariat. The following article is based on information communicated to the editor by Mr. K. Okumura of the Geological Survey of Japan.

GEOTECTONIC MAP OF EAST AND SOUTHEAST ASIA: SHEETS 4, 5 AND 6

This publication (Sato, Okumura, et al., 2000) is the first product of the Geotectonic Map Project of the Coordinating Committee for Coastal and Offshore Geoscience Programmes in East and Southeast Asia (CCOP) and the Circum-Pacific Council for Energy and Mineral Resources (CPCEMR). In order to implement the project, Working Group for Compilation of the Geotectonic Map was organized, and the compilation work has been carried out since its first meeting in 1988. The final drafts of Sheets 1 to 8 of the map at the scale of 1:2,000,000 (except Sheet 7 for Papua New Guinea area, which was discarded from the project) were digitized at the Geological Survey of Japan. The publication consists of a CD-ROM and a booklet, and the CD-ROM includes the digitized data for Sheet 4 (Philippines and the adjacent areas), Sheet 5 (Western Indonesia and Malaysia), Sheet 6 (Eastern Indonesia) and also a free viewer software, MicroImage TNTatlas (see Figure 1 for sheet areas).

It was decided to represent basic and essential tectonic data (Sato and Okumura, 2000). The classification of map units introduced on the map is such as tectonic-stratigraphic units, their time ranges, their tectonic natures (basement, orogenic, reactivated cover and cover), and the ages of the tectonic events among others. These characteristics can be read directly from the colours, patterns and symbols specified for each category of the tectonic units. Other important tectonic data, such as sediments isopachs, active volcanoes, seafloor spreading magnetic anomalies, etc. are also presented.

There are thirteen separate layers for each sheet:

Layer 1: Topographic map adopted from the CCOP East Asia Geographic Map Series,
Layer 2: Shaded 3D topography, adopted from ETOPO5,
Layer 3: Tectonic provinces,
Layer 4: Age ranges of the map units,
Layer 5: Tectonic types of the unit,
Layer 6: Igneous rock types, indicated by different patterns,
Layer 7: Unit boundaries,
Layer 8: Sediment isopachs,
Layer 9: Fold axes,
Layer 10: Seafloor spreading magnetic anomalies,
Layer 11: Coast lines, adopted from GSHHS,
Layer 12: Active volcanoes,
Layer 13: Major cities.

Any combinations of these layers can be viewed by selecting the desired layers (Figure 2).

The second publication of the project, which includes the digitized data for Sheets 1, 2, 3 and 8 (Figure 1) in its CD-ROM, is now in preparation.

References

Sato, T. and Okumura, K., Digital Geotectonic Map of East and Southeast Asia (southern part) published, *ITIT International Symposium, Mineral Resources and Tectonics of Northeast Asia, Abstracts*, p.18-19, 2000.

Sato, T., Okumura, K. and Working Group for Compilation of the Geotectonic Map, Geotectonic Map of East and Southeast Asia: Sheets 4, 5 and 6; first product of the CCOP-CPCEMR Geotectonic Map Project, *CCOP Technical Bulletin, Vol. 27*, 2000.

Kyrgyzstan
INSTITUTE OF GEOLOGY
NATIONAL ACADEMY OF SCIENCES

The following article was submitted to the newsletter by Academician
Apas B. Bakirov, Director of the Institute of Geology, NAS, Kyrgyzstan.

INFORMATION ABOUT GEOLOGY OF THE KYRGYZ REPUBLIC (KYRGYZSTAN)

Bakirov A.B. and Kakitaev K.

The Kyrgyz Republic (KR) is a country which is situated within the central part of Central Asia. Until 1992 it was a republic of the Soviet Union.
It occupies the western part of the Tien Shan and partialy the Northern Pamir. The total area of KR is 198,500 km^2, and the population is 4.8 million.

Kyrgyzstan is a mountainous country. The whole country is situated at an altitude of more than 500 m above sea level. More than a half of the area is at the altitudes from 1,000 to 3,000 m, one third of its area is at altitudes from 3,000 to 4,000 m. Some peaks have altitude of 7,000 m or more (Khan Tengri is 6,995 m, Pobeda Peak is 7,439 m, and Lenin Peak is 7,134 m).

Geoscientific Organizations

In Kyrgyzstan there are several organizations concerned with geological investigation of the region.

1. M.M.Adyshev Institute of Geology, National Academy of Sciences of the Kyrgyz Republic (IG NAS KR), is a basic scientific organization carrying out fundamental research on geology of Kyrgyzstan. At the Institute scientific investigations are being carried out in three directions: a) regional geology, b) ore formation and metallogeny, and c) regional physical geography.
2. The State Agency for Geology and Mineral Resources under the Government of the Kyrgyz Republic is an organization carrying out geological survey and exploration of mineral deposits in accordance with State instructions. It issues licences for geological objects and executes all actions connected with underground resources of Kyrgyzstan.
3. U.A.Asanaliev Kyrgyz Mining-Metallurgical Institute, the Ministry of Education, Science and Culture of the Kyrgyz Republic. This Institute of higher education trains engineers in geology, exploration, development of deposits, refining and metallurgy.
4. The Institute of Seismology, NAS KR, carries out investigation on seismic zoning, dynamics of earthquake focuses and neotectonics. All geological investigations of the institute submit to relivation of localization of seismic activity.

Geological Investigations and Publication of Geological Maps

Geological investigation of Kyrgyzstan has progressed fairly well: geological mapping at the scale of 1:200 000 has been completed for the whole country, and 75% of the area has been covered by the scale of 1:50 000. The level of geological investigations and publications of geological maps are characterized in such a way: 2 type of maps: geological and mineral resources, scale 1:200 000, have been prepared and published almost for the whole territory of Kyrgyzstan (of the 53 sheets for the whole country, 48 sheets have been published), 13 maps at a scale of 1:500 000 have been made, and 6 sheets have been published.

List of geological maps of the Kyrgyz Republic

Scale 1:500 000

1. Geological map	- published
2. Mineral resources map	- published
3. Tectonic map	- published
4. Metamorphic map	
5. Geodynamic map	
6. Prognos-metallogenic map	
7. Quaternary sediments map	
8. Geomorphological map	
9. Neotectonics map	
10. Hydrogeological map	- published
11. Lineaments and circular structures map	- published
12. Gravimetric map	
13. Map of magnetic anomalies	- published

Scale 1:200 000

1. Geological maps, 48 sheets	- published
2. Mineral resources maps, 48 compilations	- published

Geological Structure and Development

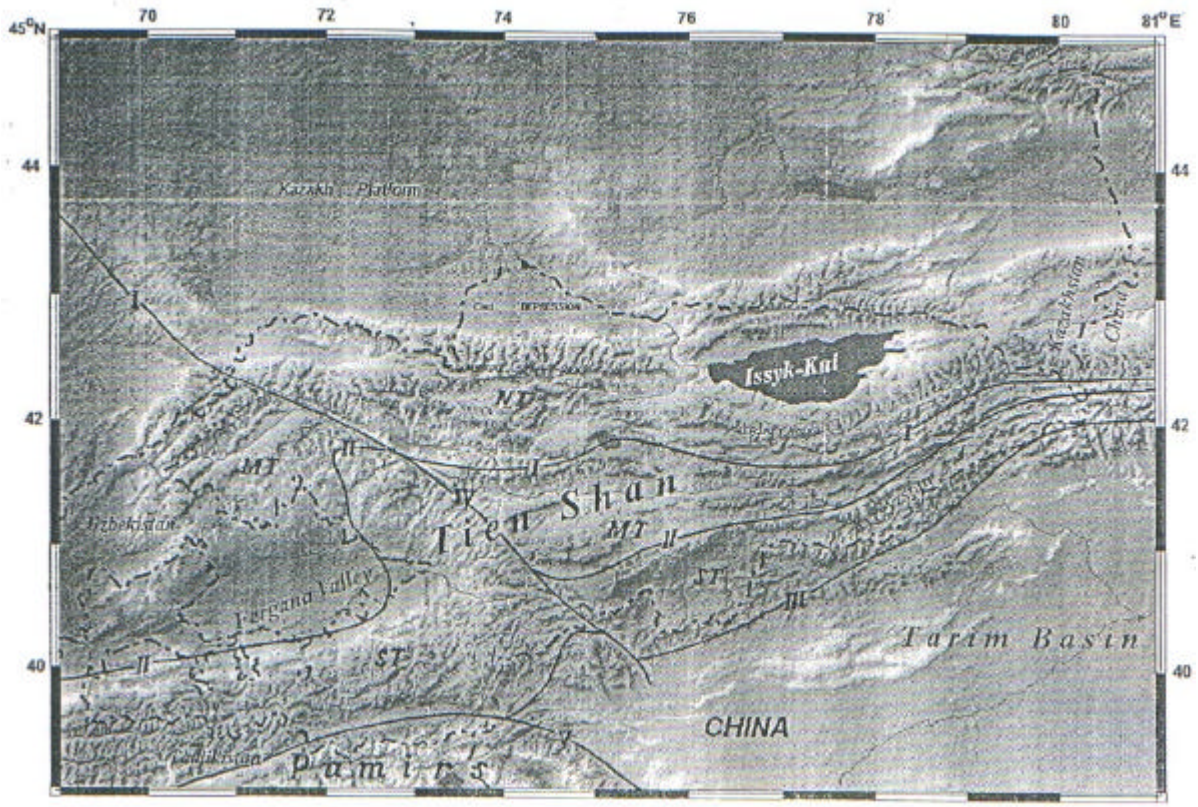
Kyrgyzstan is in a geologically unique position. Two global structures collide here, namely the Paleozoic Ural-Mongolian folded-thrusted belt and the Mesozoic Alpine-Himalaya belt. This is the result of horizontal movement from opposite directions (at different times). These belts sharply depart from each other when they go out of the Kyrgyz Republic territory.

The main folding of Kyrgyzstan is divided by age into following regions: Caledonian Northern Tien Shan; Caledonian-Variscan foldings of the Middle Tien Shan; Variscan Southern Tien Shan; and Kimmeridgian North Pamirs. Each of these regions is subdivided into a series of tectonic zones including rigid massifs of various dimensions. Neighbouring tectonic regions are divided from each other with large regional faults, which have their own geographic names. The boundary line between the North and Middle Tien Shan is the most famous and bears the denomination "The most Important Strucural Line of Tien Shan" or "Nikolaev's Line".

In stratigraphic succession the region includes the complexes of the different ages - from Archean to Cenozoic inclusive. They can be classified in the following supercomplexes: Archean - lower Proterozoic, lower-middle Proterozoic, upper Proterozoic - Paleozoic, Mesozoic-Cenozoic.

Archean - lower Proterozoic supercomplex is gneissose basement of the region. It is represented by various gneisses, migmatites, crystalline schists, marbles, amphibolites, eclogites, which were formed under mobile tectonic environment, and nowadays are basement of rigid massifs and cores of anticlinoria. In most cases their age is defined by the methods of absolute geochronology (mainly by uranium-lead method) and is characterized by the dates 2.6-1.8 Ga. However there are many cases when the age of such formations is defined conditionally.

Lower Proterozoic-Middle Proterozoic supercomplex is represented by quarzites, marbles, different crystalline schists formed under continental stable tectonic environment. Their age 1.8-1.1 Ga is defined by radiogeochronological methods.
Upper Proterozoic-Paleozoic is the most complex and large-scale supercomplex of the region. It has been investigated quite well and is separated in detail. It consists of many different rocks: sedimentary, magmatic and metamorphic. The nature of these geological complexes range widely such as, stable continental environment, epicontinental riftogenesis, ophiolites, island-arc situations, active and passive continental margins, and collision of the continents. All the system and series of Paleozoic have been dated by different organic remains. The Precambrian system was dated by geochronology (1.1-0.6 Ga).



Situation of Kyrgyzstan

Main tectonic zones of Tien-Shan. NT, Northern Tien-Shan; MT, Middle Tien-Shan; ST, Southern Tien-Shan.

Main Tectonic faults of Tien-Shan. I, "Main Line of Tien-Shan"; II: Southern Fergana-Atbashy-Inylchek fault; III, Gissar-Kokshaal fault; IV, Talas-Fergana fault; V, Northern Pamir fault.

Mesozoic-Cenozoic supercomplex. Mesozoic is represented by epicontinental interplate sedimentary units, and here and there by magmatic complexes of tranquil tectonic environment. Marine sediments have been determined only in the western and southwestern parts. In the greater eastern part of the region they are represented by continental formations. They are also characterized by organic remains, and in the marine part they are well separated.

Cenozoic, beginning with Eocene, is generally composed out of continental, subaerial molasses of intermountain depressions. It has been studied in detail, separated and dated by organic remains, partially paleomagnetic researches and radiometric age determination.

The geological bodies in Kyrgyzstan have been investigated sufficiently. Their genesis and the tectonic conditions of formation have been clarified. The results allow us to mark out, today, the following stages of the earth crust development of the territory of the Kyrgyz Republic.

By Archean - Early Proterozoic, the most ancient oceans and continents existed in the territory of Kyrgyzstan. The presence of relics in the rocks of ophiolite complex, transformed to amphibolites and here and there in eclogites among metamorphic complexes testifies to the presence of the most ancient ocean. Among the first relics are gabbro and ultrabasites. Wide development of gneisses with marbles and quarzites with signs of their formation at the expense of primary terrigenous rocks speaks in favour of existing continental situations at that time. The presence of eclogites - the rocks of metamorphism of low temperatures but high pressure - indicates the existence of subduction zones. The presence of vast tectonic covers, thrust of the ancient oceanic crust over the continental one and subsequent migmatization, point to the formation of granite plutons. Apparently, by that time mechanism of plate tectonics operated in the earth crust.

On the territory of Kyrgyzstan, the situation of interplate quiet continental tectonics prevailed during the great part of Proterozoic, which covered a part of Early, Middle and a part of Late Proterozoic. Wide development of quartzites, carbonaceous rocks and alkali-basaltoids shows the relative quiet geologic environment at that time. However the display of folding and the presence of granite plutons on three levels point to epicontinental tectonic reanimations.

It is possible to retrace in detail the evolution of tectonic conditions of Late Proterozoic-Paleozoic. The end of Proterozoic and the beginning of Paleozoic was marked by domination of epicontinental rift-genesis situation. At that time coarse clastic sediments with display of antidromic bimodal alkaline magmatism were formed. Later on they were replaced by back-arc basins with oceanic crust within the North Tien Shan Sak* Ocean. Together with ophiolites large series of tuffs, tuffites and terrigenous rocks, among which turbidites play the great role, were formed. At the same time to the south from the Middle Tien Shan, the Turkestan Ocean not less than 2 000 km wide (according to the data of paleomagnetic researches) appeared. In the middle-Late Ordovician and Silurian the closing of all back-arc basins and the unification of all the continental blocks of the North and Middle Tien Shan, which formed the so-called Kyrgyz continent, took place. On that territory orogen appears, folded movements with vast development of tectonic covers took place, thick molasses and granite batholithes were formed. At that time to the south from the Middle Tien Shan and within the South Tien Shan, oceanic environment with typical oceanic ophiolites and island-arc formations continued to dominate (to prevail). However, the largest part of the South Tien Shan represented a passive margin of the great Eastern European-Tarim continent, being united in former times, and large series of carbonates were deposited.

In the second half of the Devonian - Early Carboniferous the process of closing the Turkestan ocean from north to south began. A subduction zone was formed in its northern margin. This is confirmed by the appearance of metamorphic rocks of jadeite-glaucophane type (glaucophane schists and eclogites). However, to the south from Tien Shan, within the North Pamirs the opening of the other ocean took place. Here, in the Early Carboniferous large complexes of ophiolites were formed.

In the Middle Carboniferous, the process of closing of the Turkestan ocean becomes most intensive, the obduction of the oceanic crust to the South Tien Shan passive margin takes

place, vast tectonic covers are formed, thick series of olistostromes and flysch are deposited. At that time the monocline of the South Tien Shan, consisting of overthrust sheets from three to seven packets, was formed. Movement of geologic bodies from north to south was determined through the study of sedimentary facies.

The North Tien Shan together with the Middle Tien Shan was an active margin of the continent. Accumulation of large volcanic complexes and various granitoid plutons were emplaced. Around this time, subduction occurred in two opposing directions in the eastern part of this region. They are, from the south - the subduction of the Turkestan ocean, and from the north - Zhungar-Balkhash subduction. Here two mirror-symmetric subduction zonations were formed.

Late Paleozoic, especially Permian, is characterized by full disappearance of the oceanic-type structures occurred by the accretion of all the continental blocks, by formation of common collage structure within the whole territory of Tien Shan and the Pamirs. At that time coarse clastic molasses, collision granite plutons were formed in many localities. In Late Permian - Early Triassic the Kyrgyz Republic and adjoining regions came under tranquil interplate continental environment, and intrusion of alkaline massif- nepheline syenites, effusion of alkaline volcanites took place.

During Mesozoic and the beginning of Cenozoic (up to middle Eocene), tranquil intercontinental plateau environment prevailed in the territory of the whole Central Asia. In the Triassic-Jurassic time, the region was generally situated above sea-level, and accumulation of carbonaceous subaerial sediments took place. Only in the Pamirs epicontinental marine sediments are observed. In Cretaceous and Paleocene, the sea begins to penetrate into the Fergana depression. However the major part of the Tien Shan stayed above sea level, where red-coloured sediments were accumulated. Eruption of alkaline basaltoids occurred in some places.

Re-activation of the tectonic processes and the formation of intercontinental orogenic situation started in Eocene on the whole territory of the Tien Shan and the Pamirs. The whole Kyrgyz territory became land, and judging by facies of the sediments, the mountain ranges began to form from the south. In intermountain depressions coarse clastic molasses were accumulated.

Deep seismotomographic data of the Tien Shan and adjoining areas indicate that the lithospheric plate is broken into relatively small blocks, built of compact masses. Lithospheric blocks are separated from each other with less dense and more heated masses. All the systems of mountain structures are situated between lithospheric blocks over those thickened masses. Judging by manifestation of the strong linear folding, accompanied by the tectonic covers, lithospheric blocks are moving to meet each other and create tangential compressing efforts. And this is the reason of appearing the mountain ridges. In the lower part of the eath crust in most cases the layers composed of soft, partially melted rocks, have been determined. Apparently it acted as a lubricant for relatively free migration and deformation of the upper part of the crust. Under Fergana depression and neighbouring Tien Shan orogen the earth crust does not possess a soft layer. And this is perhaps the reason for their low hypsometrical position.

The above is basically the main geological structure and development of the territory of the Kyrgyz Republic.

Mineral Resources

Geologists of the Republic have found a rich diversity of mineral types of great economic value in the depths of alpine regions. It is an established fact that they can influence the

further development of the industry and economy of the Republic. Deposits and occurrences of 115 types of minerals have been discovered in Kyrgyzstan's territory. The state resources inventory contains more than 17,000 objects of natural types of mineral raw materials, including more than 1,000 economic deposits and ore occurrences. At present, the State has more than 250 prospected deposits. There are deposits of coal, oil, gas, non-ferrous and rare metals (copper, lead, zinc, antimony, tin, tungsten and others), gold, rare earth and radioactive elements, various types of construction materials, chemical and ore bearing rocks, other raw materials, semi-precious stones, underground fresh and thermal ground water.

Mineral resources of the Republic are not restricted to the supplies of discovered deposits. There are also more than 2,500 deposits of different types of minerals.

Gold

The Republic already has substantial gold resources in the large developed deposits of Kumtor, Jerui, Makmal, Taldybulak Levoberezhny, and in the small and medium deposits of Chatkal, Turkestan, Prisonkul, and Aktyuz-Boordu ore regions.
The Kumtor deposit is among the 10 largest gold deposits in the world.

Lage gold resources are concentrated in complex ores: gold-copper, gold-antimony, gold-polymetal, gold-cobalt, and other deposits. In such mineral types, gold is usually a residual component and its extraction from the ore is technologically difficult and sometimes economically inefficient. Nevertheless, some countries carry out large-scale industrial processing of combined ores and considerable quantity of gold is realized. In the territory of Kyrgyzstan, a group of gold-copper deposits were discovered and explored to differing degrees in the basins of the Chatkal and Sandalash rivers (deposits Kuru-Tegerek, Kichi-Sandyk, and others), and on the southern slope of the Kyrgyz mountain ridge in the Talas depression (deposits Taldybulak, Andash, Aktash, and others). The Savoyardy deposit in Eastern Alai is gold-antimony. Gold-cobalt is the major mineralization of Chalkuiryuk-Akjilga group of deposits in Turkestan-Alai. The Kuranjailyau deposit in the Kyrgyz ridge is gold-polymetal. Gold and bismuth characterize the Mironov deposit in the Kapkatas mountains.

Gold is mined at the Makbal deposit by a group of gold enterprises of the State Concern "Kyrgyzaltyn". Open-cut mining takes place there. Annual capacity is 500 thousand tons. The underground pit is on the stage of preparation. During the period of operation the gold-ore enterprises produced more than 20 tons of gold. Ore dressing is gravitational, the extraction of gold from concentrate is cyaniding. The output of gold is 85%.

In the nearest future (1-3 years) 2 large enterprises will start operating - Jerui, Taldy-Bylak-Levoberezhnyi, and some small mining enterprises. Besides since 1993, in different regions of the Republic, state and non-state enterprises began eluting of gold in placer deposits.

Silver

Silver has been popular in Asian countries since ancient times. Skillful craftsmen made beautiful jewelry and objects for everyday use. In the territory of Kyrgyzstan, ancient miners extracted a large amount of silver ores from the northern slope of the Talas ridge. Geologists often find traces of large-scale mining works there, which are good signs for prospecting. Judging by the results of exploration in the western part of the Talas ridge, it has been predicted that under favorable geological and economic conditions, a group of large silver deposits (Kumyshtag, Babakhan, Jolsai, and others) would be developed. In addition to pure silver deposits, this metal can be found in the ores of many of Kyrgyzstan's polymetal deposits, and it can be extracted in large quantities there.

Ferrous Metals

Substantial deposits of ferrous metals -iron and titanium- have been discovered in Kyrgyzstan, but they are not exploited yet. The most promising for industrial exploitation are iron deposits: Jetim in Naryn Region (a stratiform-metamorphogenic type with reserves of more than 5 billions tons of ore), and Gava and Nadir in the south of the Republic. One of the

largest deposits in the Talas ridge is the deposit of vanadium-bearing titanium-magnetite ore, Bala-Chichkan. Given Kyrgyzstan's exploitation, the development of deposits containing 50-100 million tons is expedient. The development of our own ferrous metallurgy is very important for the country.

Non-ferrous and Rare Metals

The raw material base of non-ferrous and rare metals is demonstrated in the aluminium, copper, bismuth, tin, tungsten, mercury, and antimony deposits. Nepheline syenites of the Sandyk and Zardalek deposits containing 20-22% of aluminum oxide can be used for aluminum production. The resources of the deposits are considerable. The technological method of raw materials processing of both deposits requires a large amount of electric power, but aluminum's residual products can be soda, potash, and cement.

Copper production in the Republic can be carried out on the raw material base of the Kuru-Tegerek and Bozymchak deposits prospected in the Chatkal region. In addition, there are some porphyry copper deposits under economically favorable conditions in the northern part of the Talas depression, which has not been completely explored (Taldy-Bulak, Aktash, Andash, and others). The ores of these deposits contain some gold.

In the former USSR, Kyrgyzstan was the main mercury producer. The Khaidarkan mercury enterprise is supplied with ore from the well-explored Khaidarkan, Chauvai, Novoye, and Chonkoi deposits. The total mercury stock consists of about 45,000 tons and it guarantees continual work for the enterprise for a long period.

The output and process of mercury is produced by Khaidarkan mercury enterprises. The deposits Khaidarkan, Novoe and Chonkoi are mainly exploited by underground method, and a small part - by open pit (4 pits). Annual production of mercury is 750-800 tons. Summary balance reservers of mercury are more than 43 thousand tons. Metallurgy of mercury consists in ore roasting in chimney kiln and condensation. The output of metal is 92%. The remains of roasting of complex ores are sent for further processing to Kadamjai mercury enterprise.

Antimony is a traditional mineral in Kyrgyzstan. The Republic has only one antimony enterprise in the CIS in Kadamjai. Its raw material base is supplied from six deposits, four of them (Kadamjai, Tereksay, Khaidarkan, and Novoe) are in operation, and two of them (Kassan and Tunduk-Aktash) are in reserve. But the processing technology for the arsenic-containing ores of the Kassan deposit is not worked out. A prospective antimony deposit, Chaarat, has been discovered and is being explored in the Chatkal region, in the basin Chandalash river.

The production of antimony is carried out by one firm in the former Soviet Union, the Kadamghai antimony enterprise with complete metallurgic process on producing antimony.

Kadamjai enterprise uses not only Kyrgyz ores but the ores from Yakutia and Tajikistan. Ore concentration is carried out by flotation (in concentrate - 30-40% of antimony) and metallurgical redivision is produced with the help of electromelting. The output of metal is 85%.

Tin and tin-tungsten mineralization are known in the Saryjaz ore region, together with the well-explored Trudovoy, Uchkoshkon, and Kensu deposits. The Saryjaz tin enterprise is being built on the base of these deposits. Small tin and tungsten deposits are situated in the Turkestan-Alay, Talas, and Aksai-Myudyuryum regions.

We would also mention prospected deposits of bismuth (Mironov), beryllium (Kalesai), rare earth elements (Kutessai), lead (Jergalan), and polymetals (Kurgan).

The Kyrgyz Mining and Metallurgical Enterprise receives group of rare-earth elements from Kutesai deposit. Annual ore output by open-cut method is possibly up to 250 thousand tons. Aktjuz concentrating mill uses flotation, and concentrate is sent to chemical-metallurgical department of the Kyrgyz Mining Metallurgical Enterprise, where 14 rare-earth elements and oxides of metals are extracted.

Within the southern part of the Southern Tien Shan there are a number of carbonatite bodies closely connected with massives of alkaline syenites. Carbonatites, which contain tantalum and rare-earth elements, have large prospectivity. However, exploration of these carbonatites is yet insufficient.

Oil and Gas

Oil and gas deposits are situated in the northeastern part of the Fergana valley; they occur in Mesozoic-Cainozoic sediments. All the deposits have many strata, which can be oil (Chyghysh Izbackent), gas (Kyzyl-Alma, Suzak), and gas condensate (Tunduk Karakchykum). According to the geological and geophysical data and a construction model based on the geodynamic analysis of geology, scientists predict substantial deposits of hydrocarbonic raw material in the Chygysh-Chu, Aksai, Naryn, and other mountain depressions.

Coal

Kyrgyzstan has about half of all the coal resources in Central Asia. Brown and bituminous coal deposits are situated in the Tushtuk-Fergana (Sulyukta, Kyzyl-Kiya, Beshburkhan), Uzgen (Kok-Yangak, Tashkumyr, etc.), Kavak (Minkush, Kara-Kiche, etc.), Issyk-Kul (Jergalan, Soguty), and Alay (Norus-Kul) coal-fields. Coal mining is mainly carried out in the south of the Republic, usually by open-cast mining. The latest exploration revealed a new brown coal field in the country between Sokh and Shakhimardan with forecasted resources of about 5000 million tons.

In the prospective Uzgen basin with coking coal and anthracite coals the mining operation has been stopped. It is necessary to carry on extra geoprospecting works to organize the mining of high-quality coals of the Uzgen basin.

Nonmetallic Minerals

Many deposits of nonmetallic minerals have been discovered in the territory of Kyrgyzstan - facing stone, cement raw material, ceramasite and aggloporite, construction sand, limestone and stone, sand and gravel mix, rough clay and construction ceramics, gypsum, rodusite-asbestos, salt, and others.

The facing materials from natural stone (marbles, granites, limestones, etc.) have diversity in colour, physico-mechanical and other characteristics of prospected reserves (43 million cubic meters). In different regions of the Republic (Osh, Tokmak, Ivanovka, etc.) rock-manufacturing enterprises have been built. Their production capacity is from 20 to 200 thousand square meters of plates annually. Because of the economic difficulties of Kyrgyzstan and former Republics of the USSR, nowadays those enterprises do not work with full capacity. The possibility of increasing the prospected reserves of natural dressing stone in the Republic is considerable. Building industry of the Republic (brick-tile raw materials, sand-gravel materials, raw materials for keramzite industry, gypsum and others) is completely supplied with local raw materials. In Kyrgyzstan the deposits of wollastonite, rhodusite-asbestos (blue asbestos), graphite, basalts and other rocks and minerals were discovered and researched, some of them have been prepared for industrial exploitation.

Most of these deposits are used in industry with products being widely used in different branches of public and private sectors. But materials such as porcelain, graphite, decorative stone, decorative facing stones, and others, can satisfy Kyrgyzstan's needs and be exported as well.

Mineral Waters

The Republic has substantial resources of thermomineral waters possessing high therapeutic qualities. They are effectively used in the Issyk Kul and Jalai-Abad regions, where there are many health centers and holiday hotels with a very highly effective treatment (Jalal-Abad, Jety-Oguz, Issyk-Ata, Teploklyuchenka, and others). Mineral waters of Arashan, Kara-Shoro, Ak-Suu, and Frunze are used for bottling.

More than 100 occurrences of fresh and thermal underground waters give considerable possibilities for their utilization. At present only small part of these are being used.

The degree of exploration of the numerous mineral deposits is varied. The majority of medium and especially small deposits remain unexplored, so the prospects of discovering new industrial materials in Kyrgyzstan are highly likely.

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*named after ancient Central Asian nation.

Further information may be available from:

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Thailand
GEOLOGICAL SURVEY DIVISION
DEPARTMENT OF MINERAL RESOURCES

The following article is from a recent GSD's brochure, which Dr. Prinya Putthapiban kindly sent to the editor.

BACKGROUND

Prior to the establishment of the Geological Survey Division (GSD) of Thailand on 18 August 1941, it was first founded as a subsection in the Thai Royal Department of Mines. In the early period of the section which was during the Second World War, its mandate aimed at mineral exploration for mining locally for the purpose of serving the country demand.

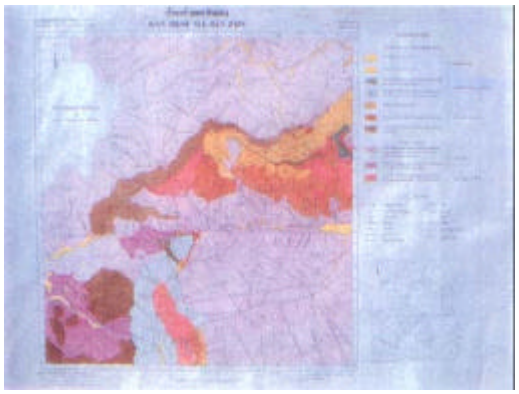
The Royal Department of Mines was later adjusted and improved to be the Department of Mineral Resources (DMR) and the GSD's activities became more international. Five to six years after the end of Second World War, the geological investigation was carried out with the cooperation of the US Geological Survey which subsequently published the report entitled "Geological reconnaissance of the mineral deposits of Thailand" as Geological Survey Memoir No.1 in 1953. This report includes the reconnaissance geological map of Thailand at the scale of 1:2,500,000.

During 1951 - 1962, the overseas cooperation in terms of geological survey and research were steadily increased, for example, cooperation with the United States and Japan. This led to realize that the information obtained from the systematic geological mapping was necessary to the development of the country.

The new era of the GSD during the period 1961 - 1966, dealt heavily with rapid expansion of geological tasks concerning geological investigations and researches. In 1964 once the division was restructured. Some sections of the GSD were disassociated and magnified to establish some new divisions e.g. the Economic Geology Division, Ground Water Division, etc. As a result, the GSD concentrated on more systematic geologic mapping of Thailand. In 1965 GSD initiated the project of systematic geological mapping that was supported by German government. The mapping had been accomplished by Thai geologists in collaboration with German Geological Mission (GGM). They carried out some geologic maps at the scale of 1:250,000, mainly of the northern and part of the western Thailand. The first published geologic map was the Lampang sheet which was achieved by only Thai geologists. After having completed the projects in 1971, GSD itself continued mapping and finally accomplished 52 published map sheets at the scale of 1:250,000, covering the whole country in 1984. The more detailed geology of Thailand has been mapped since 1977 at the scale of 1:50,000. Recently, the detailed geological investigation of about 300 map sheets has been carried out. In addition to fundamental geological mapping, various fields of geology have been performed such as geothermal exploration, stratigraphic correlation, granitic rocks dating, paleontological research, environmental geology study, etc.

Map of Mineral Resources obtained from geological mapping on the scales of 1:50,000 and 1:250,000.

Detailed geological mapping of dimension stones in the potential areas.



The geologic map of Ban Huai Ma Hin Fon sheet on the scale of 1:50,000.

Drilling to study the coastal change.

Collection of fault materials for age determination.

Thermoluminescence dating equipment.

ORGANIZATION STRUCTURE

Geological Survey Division

Director:
Phone:+662-202-3735/644-8787 Fax: +662-202-3754

Experts

Geological Mapping Section Chief: *Dr. Thanis Wongwanich*
Phone:+662-202-3739-40

- Northern regional mapping unit
- Northeastern regional mapping unit
- Central and eastern regional mapping unit
- Western regional mapping unit
- Southern regional mapping unit
- Survey and mapping unit
- Industrial and constructional carbonate rocks mapping unit
- Soil-pit inspection unit
- Geological standardization unit

Environmental Geology Section Chief: *Mr. Sin Sinsakul*
Phone:+662-202-3752 Fax: +662-202-3753

- Environmental geology unit
- Geotechnic unit
- Survey and Mapping unit

Photogeology & Remote Sensing Section Chief:
Phone:+662-202-3744-45

- Aerial photo interpretation unit
- Detailed photogeology unit
- Satellite imageries interpretation unit
- Structural geology unit
- Survey and mapping unit

Paleontology Section Chief: *Ms. Benja Sektheera*
Phone:+662-202-3746-47

- Vertebrate-paleontology unit
- Invertebrate-paleontology and palynology unit

Geological Research Section Chief: *Mr. Sirot Sulyapongse*
Phone:+662-202-3742-43

- Igneous rocks research unit
- Sedimentary rocks research unit
- Metamorphic rock research unit
- Fluid inclusion research unit
- Palaeomagnetic research unit

Geological Museum Section Chief: *Ms. Benjawan Charukalas*
Phone:+662-202-3669-70

- Geological materials collection unit
- Exhibition and educational service unit
- Museum artwork unit

Industrial Rock Resources Section Chief: *Dr. Pol Chaodumrong*
Phone:+662-202-3757/3748

- Granitic rock resources investigation unit
- Carbonate rock resources investigation unit

Geological Cartographic Section Chief: *Ms. Supawadee Vimuktanandana*
Phone:+662-202-3755/3751

- Map producing unit
- Map drafting and color separating unit
- Map data supply unit
- Map revision unit

Quaternary Geology Section [Unoffcial] Chief: *Mr. Saman Chaturongkawanich*
Phone:+662-202-3759

- Flood plain and coastal plain investigation unit
- Land accretion inspection unit

International Geology Section [Unofficial] Chief: *Dr. Prinya Putthapiban*
Phone:+662-202-3743

Geological Information Section Chief: *Dr. Sunya Sarapirome*
Phone:+662-202-3758

General Administration Section [Unofficial] Chief: *Ms. Nopakoon Tanaruengskulthai*
Phone:+662-202-3756/3737

PRINCIPAL ACTIVITIES OF THE GSD

1. Geological investigation of the country and geological map production.
2. Analysis and assessment on environmental geological data and information as well as environmental geological investigation and mapping.
3. Geological interpretation using remote sensing data and techniques.
4. Study and research on fossils.
5. Study and research on sedimentary, metamorphic, and igneous rocks.
6. Evaluation and recommendation on potential use of industrial rocks.
7. Encouragement on geological information and geological knowledge.
8. Publication of standardized geological maps.
9. International cooperation in the fields of geology and geological resources.
10. Development and distribution of national geological database.

ORGANIZATION

The GSD is a part of the DMR which in turn is a raw material information provider of the Ministry of Industry (MOI). There are 130 officers working for the GSD. This group consists of 71 geologists, 35 surveyors and 24 for administration services.
The organization of the GSD is divided into 12 sections as follows:

1. Geological Mapping Section.
2. Environmental Geology Section.
3. Photogeology and Remote Sensing Section.
4. Paleontology Section.
5. Geological Research Section.
6. Geological Museum Section.
7. Industrial Rock Resources Section.
8. Geological Cartographic Section.
9. Quaternary Geology Section. (unofficial)
10. International Geology Section. (unofficial)
11. Geological Information Section.
12. Central Administration Secion. (unofficial)

GEOLOGICAL MAPPING SECTION

The section is responsible for geological survey and mapping throughout the whole country and expressing in various detailed levels. Detailed mapping at the scale of 1:50,000 in the high potential area is being carried out so as to serve mineral resources exploration and other developing programs. In addition to mapping, the inspection on the license applications of land use according to the section 9 and 12 of Land code and setting the geological standard are included. The section consists of 9 units as follows:

1. Northern regional mapping unit.
2. Northeastern regional mapping unit.
3. Central and eastern regional mapping unit.
4. Western regional mapping unit.
5. Southern regional mapping unit.
6. Survey and mapping unit.
7. Industrial and constructional carbonate rocks mapping unit.
8. Soil-pit inspection unit.
9. Geological standardization unit.

ENVIRONMENTAL GEOLOGY SECTION

The section is responsible for investigation, analysis, assessment and compilation on several themes in field of geology so as to apply for conservation, prevention, and solving the environmental problems, especially with regard to the suitable mineral resources exploitation and consumption, land use, and mitigation of the geo-hazards effects.
The section is divided into 3 units as follows:

1. Environmental geology unit.
2. Geotechnic unit.
3. Survey and mapping unit.

PHOTOGEOLOGY AND REMOTE SENSING SECTION

Main task is geologic interpretation from aerial photos resulting in preliminary photogeologic maps which are used to support systematic geological maps of GSD. Detailed investigation of the mineral potential and mined area for the conservation and development planning, based on aerial photo interpretation, is also conducted. Additionally, the geologic structures are interpreted from satellite imageries to yield the structural and tectonic maps which is useful for further geological resources exploration.
The section is divided into 5 units as follows:

1. Aerial photo interpretation unit.
2. Detailed photogeology study unit.
3. Satellite imageries interpretation unit.
4. Structural geology unit.
5. Survey and mapping unit.

PALEONTOLOGY SECTION

The section plays roles on fossil study so that age of sedimentary rocks in Thailand can be determined. Results are useful for stratigraphic correlation and the increasing rectification of the stratigraphic sequence in geological mapping.
Recently, the section has been responsible for two more projects, i.e., dinosaur museum development in Kalasin and Phu Wiang dinosaur museum development in Khon Kaen.

The projects will be completed in 2000, and expected that there will be the Dinosaur Research Center at Kalasin and Dinosaur Information Center at Khon Kaen. In addition, the dinosaur museums will become the places for tourist attraction.
The section is divided into 2 units as follows:

1. Vertebrate-paleontology unit.
2. Invertebrate-paleontology and palynology unit.

Structural Geologic Map of Thailand interpreted from Landsat imageries

Photogeological Map of Amphoe Rong Kwang sheet interpreted from aerial photos.

The temporary Phu Wiang dinosaur museum at the meeting hall of Amphoe Phu Wiang, Khon Kaen Province.

The pit of herbivorus dinosaurs bones at Phu Khum Khao, Amphoe Sahatsakhan, Kalasin Province.

The palaeomagnetic cored specimens (25mm. In diameter) were collected by drilling with hand-drilling machine.

The spinner magnetometer (SSM-2) is used for measuring the remanent magnetisation rocks.

GEOLOGICAL RESEARCH SECTION

The section is responsible for the investigation, experiment, and research in various fields of geology in order to obtain the new geological theory of the country. The researches concentrate on stratigraphy and sedimentation, granitic rocks, volcanic rocks, metamorphic rocks, mineral occurrences using fluid inclusion method and age dating using palaeomagnetic method.

The section is divided into 5 units as follows:

1. Igneous rocks research unit.
2. Sedimentary rocks research unit.
3. Metamorphic rocks research unit.
4. Fluid inclusion research unit.
5. Palaeomagnetic research unit.

GEOLOGICAL MUSEUM SECTION

The section is responsible for organizing the collection of geological materials i.e., minerals, rocks, and fossils for displaying in the museum. Conduction on exhibition of geologic resources as well as mining industries all over the country. These activities encourage geological knowledge in term of providing museum information for any educational institute requests.

The section consists of 3 units as follows:

1. Geological materials collection unit.
2. Exhibition and educational service unit.
3. Museum artwork unit.

INDUSTRIAL ROCK RESOURCES SECTION

The section is responsible for investigation through classifying and mapping industrial rocks and dimension stones in searching for potential sources and suitable quality throughout the country. The purpose is aimed at locating potential areas for aggregates, dimension stones and cement industry for the best benefit of their utilization. Supporting industrial rock data and information to the government and private sectors.

The section is divided into 2 units as follows:

1. Granitic rock resources investigation unit.
2. Carbonate rock resources investigation unit.

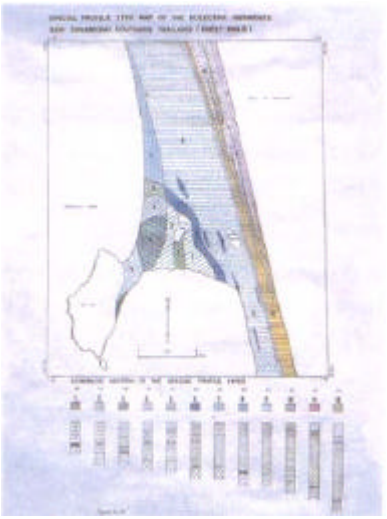
GEOLOGICAL CARTOGRAPHIC SECTION

The section is in charge of preparing and publishing various kinds of maps in form of hard copy that meet the international cartographic standard. These maps include geological maps and other geological related maps at various scales.

The section is divided into 4 units as follows:

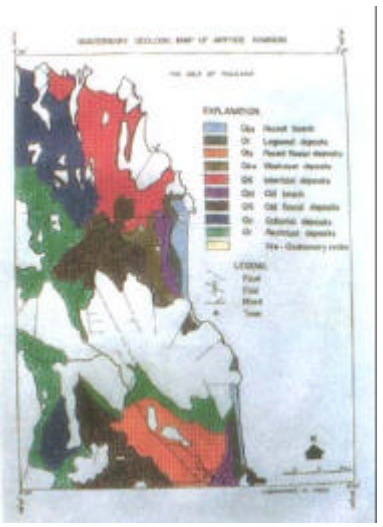
1. Map producing unit.
2. Map drafting and color separating unit.
3. Map data supply unit.
4. Map revision unit.

The geologic map of Thailand on the scale of 1:2,500,000.



The Profile Type Map, Ban Sanamchai sheet, Changwat Songkhla, showing the overlay of each subsurface sedimentary units.

Showing the collection of coastal clay sample (undisturbed-sample) in order to be analysed by means of physics, chemistry and paleontology.



The Quaternary Geological Map, Amphoe Khanom sheet, Changwat Nakorn-srithammarat, showing the surficial sedimentary units.

Mineral Resource Museum at Department of Mineral Resources, Bangkok.

DMR exhibition on the occasion of the jubilee of Thailand & UNESCO joint-cooperation at Central Plaza Hotel, 10-14 July 1996.

Fluid inclusion microthermometer is used for measuring the temperature of fluid inclusion within ore and gangue minerals to extrapolate P-T condition of ore forming fluid in the primary mineral deposits.

Marble, light gray at dimension stone mine in Thoen District, Lampang Province. Marble, light gray at dimension stone mine in Thoen District, Lampang Province.

Quarry of limestones for cement industry at Saraburi Province.

Aggregate quarry shows folded-bedded limestones of Permian period, in Loei Province.

QUATERNARY GEOLOGY SECTION

The section is responsible for the study on unconsolidated-sediments and economic minerals deposits in coastal plains, flood plains, and intermontaine basins. Geological investigations and drillings are used for preparation the Quaternary Geological Map and Profile Type Maps.
The section is divided into 2 units as follows:

1. Flood plain and coastal plain investigation unit.
2. Land accretion inspection unit.

INTERNATIONAL GEOLOGY SECTION

The Geological Survey Division has studied, compiled and cooperated with the international institution and organization, in particular those of the Asian countries. The aims of such activity are to obtain and to update the international geological information, especially the countries within this region and to help creating international cooperation in academics, as well as joint development of mineral resources in order to secure the raw material for the state consumption.
The International Geology Section is reponsible for the above task.

GEOLOGICAL INFORMATION SECTION

The section has been established since the mid of 1996 and recently focuses on applying inforrnation technology to develop geological information system for the GSD. Computer facility in the division and national geological database are actively set up. Available fundamental and applied geological data are captured and analyzed using computer techniques. Results are interactively utilized in terms of display and query through Geographic Information System (GIS). The section seeks for working on international cooperative project. Distribution and dissemination of geological information according to DMR policy are the section activities as well.

GENERAL ADMINISTRATION SECTION

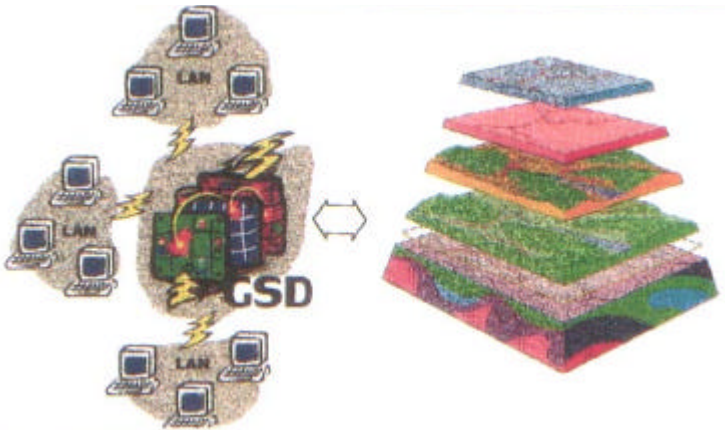
With the aim to effectively manage, facilitate and achieve the goal of Geological Survey Division which is one of the principal task of the DMR. The General Administration Section was set up to act as house-keeper looking after and facilitating document, budget, finance, vehicles, procurement, etc.

Further information may be available from:
Geological Survey Division
Department of Mineral Resources
Rama IV Rd., Ratchathewi, Bangkok, 10400, Thailand

Thai-Laos are working together closely. The solution for Technical Cooperation in the field of geology and mineral resources was discussed on 2 February 1996 at DMR, Bangkok.

Chinese delegation and the Thai counterpart have signed the Minute of Meeting on the subject of Technical Cooperation in the field of geology and mineral resources on 27 July 1996 at DMR, Bangkok.

Thai delegation and Vietnamese geoscientisis have signed the Minute of Meeting concerning the cooperative project in the field of geology and mineral resources on 7 May 1997 at DGMV, Hanoi.



Vietnam
DEPARTMENT OF GEOLOGY AND MINERALS OF VIETNAM

The following article , which was corrected from the paper "Geological Sector of Vietnam: History and achievements" (in Vietnamese), Journal of Geology, Series A, No 248, 9-10, 1988, Hanoi, was submitted to the newsletter by Prof. Dr. Tran Van Tri, former Deputy Director General of the Department of Geology and Minerals of Vietnam.

STATUS OF THE GEOLOGICAL SECTOR OF VIETNAM

Tran Van Tri

ABSTRACT

Although mining and geological activities in Vietnam had started before the Christian era, official State organizations were established only at the end of the XVIIIth century.

The "Service des Mines de la Cochinchine" (1868), the "Service des Mines de l'Indochine" (1884), the "Service Géologique de l'Indochine" (1894 and 1898) were established during the French domination.

After the establishement of the independent Vietnamese State in 1945, the Geological Survey and the Mineral Department were established, and through many changes and renovations, mergers and separations, these two organizations were joined together again with the name of the Department of Geology and Minerals of Vietnam in 1996. Besides, there are institutes, centers, universities, vocational secondary schools, corporations and companies operating in the fields of geology or mining.

Up to present, geological, mineral resources, hydrogeological, ground radiometric, gravity, aeromagnetic maps of 1:500,000 and 1:200,000 scales have covered the whole country. Hydrogeological and engineering geological, airborne magnetic, gamma spectrometric, gravity maps of 1:50,000 or 1:25,000 have also covered many important areas. At the same time, many thematic research works have been carried out. Especially prospecting and exploration of the resources or reserves of many minerals, of oil and gas and groundwater have been evaluated, many of which are being expoited.

To obtain the above achievement, the geological sector of Vietnam has made great efforts together with valuable assistance and cooperation from other countries and international organizations, to contribute to the socio-economic development of the country.

The process of formation and development of the geological sector of Vietnam has undergone many stages with inheriting and renovating character and has attained great achievements.

OUTLINE OF THE HISTORY OF THE GEOLOGICAL SECTOR

• ***The ancient times***

The old utensils and objects discovered belonging to Paleolithic, Mesolithic and especially Neolithic ages show development to the climax of the bronze and iron technology of the ancient Vietnamese. Through feudal dynasties of Ly, Tran, Le, etc., the mineral exploration and mining activities were gradually formulated and developed, although our country had to undergo many years of the Chinese domination.

• ***French occupation period (1858 - 1945)***

After the French colonialists had occupied Vietnam, they established their own mining and geological organizations to exploit the mineral resources of our country as one of their colonies.

In 1868 the "Service des Mines de la Cochinchine" was established.

In 1884 the "Service des Mines de l'Indochine" was established.

In 1888 the "Charbonages du Tonkin" was established.

In 1898 the "Service Géologique de l'Indochine" was established (although on the paper it was in 1894) [1, 14].

It should be added that in the early part of the 1940's the Japanese fascists occupied Vietnam and replaced the French colonialists. They have used the opportunity to carry out geological investigation and mineral exploitation in Vietnam.

• ***The period from the August Revolution (1945) to date***

- Period 1945 - 1954

Immediately after the August Revolution when our new State was just established with many difficulties, the Government already was paying strong attention to the reorganization of the mining and geological sector.

In 1945, the "Direction de l'Industrie" and "l'Inspection Générale des Mineraux et de l'Industrie" were established under the Ministry of National Economy.

In 1946, the Geological Survey and Mineral Department were detached from the Directorate of Technology.

In the mean time, some French organizations such as Service Géologique de l'Indochine were attributed to the "Centre de Recherches Scientifiques et Techniques" in 1951 according to the "Convention Inter-Etats sur la Plan d'Equipement", then moved to Saigon in 1954, incorporated to the "Direction Générale des Mines, de l'Industrie et del'Artisanat".

- Period 1955 - 1975

After the restoration of peace in 1954, the country was temporarily divided into two parts. In the Northern part, geological and mining works entered a new stage of systematic development with ever increasing extent, with the assistance of the former Soviet Union, China and other fraternal countries. The National Geological Survey continued to develop, universities and secondary vocational schools were established for training in geology and mining together with some research organizations.

In 1955, the Geological Survey together with the Mining Department became member organizations in the Ministry of Industry and Trade, which was changed to the Ministry of Industry in 1956.

In 1959, the Geological Department under the Ministry of Industry

In 1960, the General Department of Geology under the Council of Ministers

Also during this period, in 1966, the "Service Géologique" in the South of Vietnam was incorporated to the "Direction de Mines" and in 1968 it was moved to the "Direction des Ressources Naturelles".

In 1969 the Ministry of Electricity, the Ministry of Mechanics and Metallurgy and the General Department of Chemistry were established on the basis of the Ministry of Heavy Industry.

- Period from 1975 to date

Since the country was reunified, the many new units of General Department of Geology including those based on the Geological Survey of South Vietnam were established and operated throughout the country. In 1977 the number of staff reached 22,247 people. Basic geological survey, mineral prospecting, and exploration were promoted and uniformly developed. The system of universities and secondary vocational schools, research institutes, geological and mining associations continued to be consolidated and established.

In 1975 the General Department of Oil and Gas was established based on Geological Division No 36 of the General Department of Geology and a part of the General Department of Chemistry, which was changed to the Vietnam Oil and Gas Corporation, laying important landmarks in the history of the rapidly developing petroleum industry of our country.

In 1981, the Ministry of Mine and Coal and Ministry of Electrical Energy were established and in 1987 these two Ministries were merged into the Ministry of Energy, in which there were some organizations engaged in geological and mining activities.

In 1987, the General Department of Mines and Geology was established on the basis of the General Department of Geology supplemented by a mine management agency, directly under the Government. In 1990 the General Department was dissolved by the Resolution of the State Council, which specified the renaming of the Ministry of Mechanics and Metallurgy to Ministry of Heavy Industry.

In 1990 the Geological Survey of Vietnam and the State Department for Management of Mineral Resources were established from the General Department of Mines and Geology.

In 1990 the Rare and Precious Mineral Corporation and the Mineral Development Corporation were established under the Ministry of Heavy Industry.

In 1991 the Geological Division No 9 which was mainly engaged in coal exploration under the Geological Survey of Vietnam was transformed into the Geology and Mineral Exploitation Company under the Ministry of Energy.

In 1996, the Department of Geology and Minerals of Vietnam was established by merging the Geological Survey of Vietnam and the Department for Management of Mineral Resources, and placed under the Ministry of Industry.

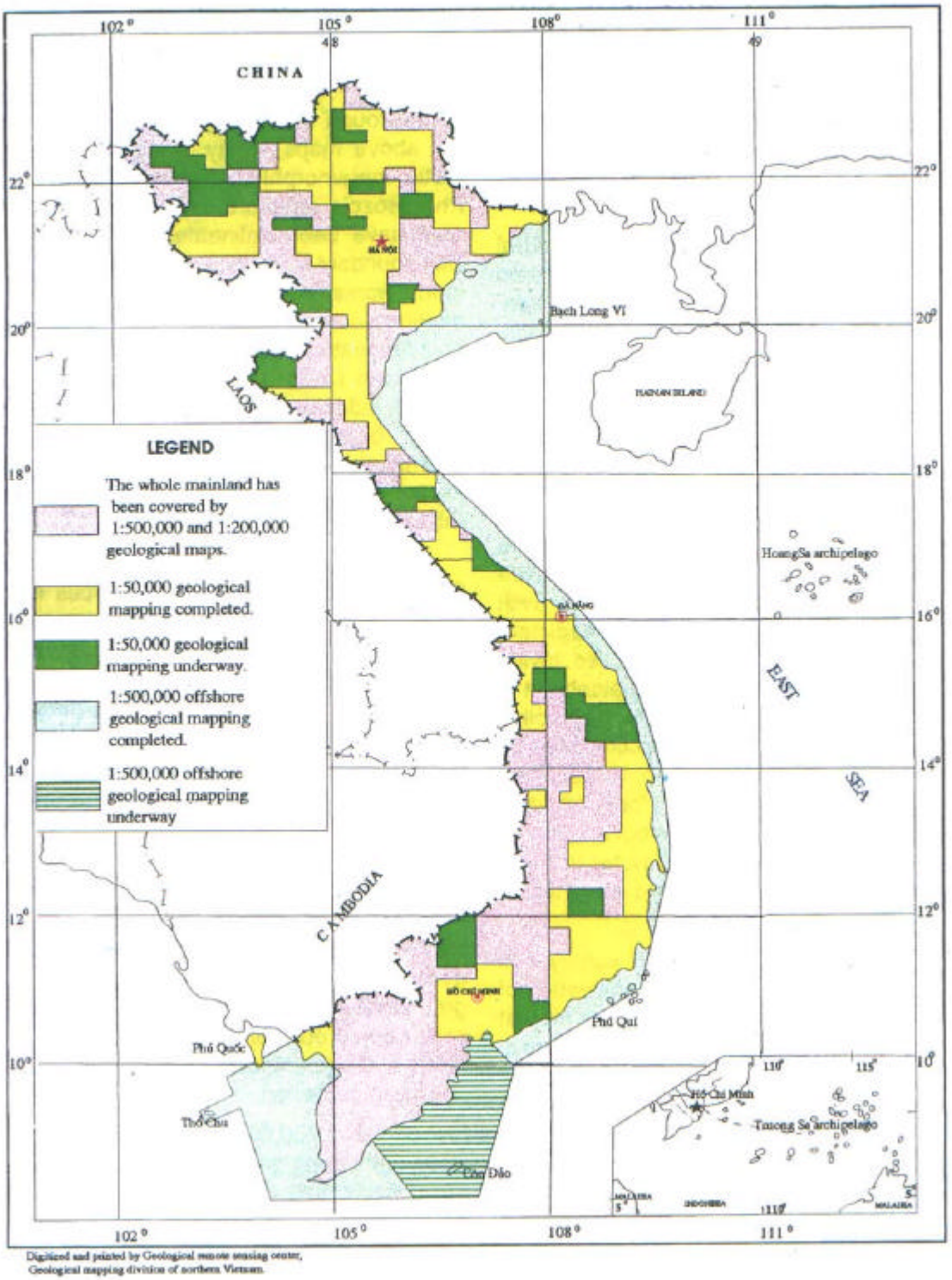
PRESENT STATUS OF THE GEOLOGICAL SECTOR

- Organization

In Decree No 79/CP dated 04 December 1996 it is specified that "The Department of Geology and Minerals of Vietnam shall be a body under the Ministry of Industry to assist the Minister of Industry to implement the specialized functions of state management of geology and mineral resources, namely: researches, basic geological surveys, mineral activities (prospecting, exploration, exploitation and minerals processing), protection of mineral resources; organize the implementation of research work, basic geological surveys of minerals and discoveries of mineral deposits within the entire country".

At present, the Department of Geology and Minerals of Vietnam consists of 18 units: Northern and Southern Geological Mapping Divisions; Northeastern, Northwestern, North Central and Mid-Central Geological Divisions; Northern, Central and Southern Hydrogeological and Engineering Geological Divisions; Geophysical Division, Radioactive and Rare-earth Geological Division, Geodetic Division, Institute of Geological Information, Archives and Museum; Marine Geology and Mineral Center; the Analytical and Experimental

Figure 1. Status of Geological Mapping
at 1:50,000 to 1:500,000 scale



Digitized and printed by Geological remote sensing center, Geological mapping division of northern Vietnam.

Center for Geology, two Regional Mineral Management Offices in the Central region and South, the Geophysical Technology Company, X15 Printing Enterprise, and professional sections at the headquarters of the Department, with a total of 4,450 staff, of which those with university and higher level training account for 38%, those with secondary vocational education over 28%.

Besides, the Research Institute of Geology and Mineral Resources and the Research Institute of Mining and Metallurgy of the Ministry of Industry, the Institute of Geology, the Institute of Geophysics, the Institute of Geography, the Institute of Oceanology under the National Center for Natural Science and Technology, the Petroleum Institute, Petroleum Information and Documentation, Petroleum Research Development and Processing Centers of Petrovietnam; the Research Institute of Mining Technology of the Vietnam Coal Corporation, the Geotechnical Institute of the Vietnam Union of Scientific and Technical Associations are also engaged in geological investigation.

A very large number of staff who carry out survey, prospecting, exploration and exploitation are in Vietnam National Coal Corporation (VINACOAL), Vietnam Oil and Gas Corporation (Petrovietnam), Vietnam Gems and Gold Corporation (VIGEGO), Vietnam Minerals Corporation (VIMICO), Vietnam Chemical Corporation (VINACHEM), Vietnam Steel Corporation (VSC), as well as in water supply and drainage, construction materials companies, etc. in various sectors and localities.

Learned societies in geology and mining consist of Geological Association of Vietnam, Mining Science and Technology Association of Vietnam, Geographical Association of Vietnam, etc., with tens of specialized associations gathering wide ranges of members for information dissemination, training, research, application, consultation, review, public evaluation of geological and mining issues.

- **Geological education and training system:** Training and researches on geology and mining are carried out in Hanoi University of Mining and Geology and many faculties of the Hanoi National University, Ho Chi Minh City National University, Ho Chi Minh City Polytechnic University, Hue University. Besides, geological staff are also trained in other institutions such as the Secondary Vocational School on Geology, the Tuy Hoa Industrial School, the Mining Engineering College, PetroVietnam's Training Center and some other related vocational and professional schools.

- **As regards manpower:** So far, although there are still no adequate statistic data, the total number of people working in the field of geology and mining is estimated to be about 150,000, excluding hundreds thousands of people carrying out survey, exploration and exploitation of construction materials in various sectors and localities throughout the country.

The scientific and technical staff is rapidly growing. During the French domination time the Vietnam geological circle comprised no more than 10 people, but now there are up to 30,000 geologists of various specialties, of which over 10,000 have university degree and some hundreds have post-graduate degrees. Most of scientific and technical staff were trained in the country, the rest were trained in the former Soviet Union and other socialist countries. In recent years some have been trained in other countries.

- **Equipment and technology:** are considerably promoted in various stages from basic geological research and survey to exploration, exploitation and mineral processing.

Aside from the existing traditional equipment for chemical analysis and physical tests, modern equipment such as AAS, ICP, X-ray fluorescence analyzer, mass spectrometer, scanning microscope, polarized microscope, neutron reactivation analyzer, TDA, are used for analyzing geological samples in recent years.

For airborne geophysical surveys, there are magnetic and gamma spectrometric survey equipment. For surface geophysical surveys, there are electrical, magnetic, gravity survey

equipment. For marine geophysical surveys, there are high resolution gravity, magnetic, radiometric survey equipment, especially 2D and 3D seismic survey equipment, which are being used for oil and gas exploration. Notable are the GPS and GIS combined with computer system which are widely applied in geological survey as well as in combination with satellite images and air photos for compilation of topographic maps and interpretation of satellite images.

- **Computation** is widely applied in the geological sector with hundreds of computers together with software programs for data processing, digitizing maps and storing them on CD-ROM. Some organizations already have workstations connected with Intranet or Internet websites.

- **Drilling, excavation** and transportation equipment have been gradually renovated. At the same time there are new drilling equipment with double core barrel, wireline system or air circulation giving high core recovery ratio. Especially drilling equipment for oil and gas exploration and exploitation in foreign joint venture projects can drill to the depth of thousands of meters.

- **Legislation** such as the Petroleum Law (1993), the Law on Environmental Protection (1994), the Mineral Law (1996), the Ordinance on Royalty Tax (1998), the Law on Water Resources (1998) of the National Assembly, Decrees, Decisions of the Government as well as Decisions and Circulars of Ministries and sectors have been promulgated to guide the implementation of those legal documents.

In the mean time, a series of regulations, specifications or technical guidelines in geology and mining as well as related State or sector standards have also been issued.

The infrastructures such as roads, electricity and water supply system, workshop buildings, laboratories, archives, museums, libraries, schools are also upgraded or built. It is notable that owing to mining development, urban areas such as Hon Gai - Cam Pha, Cam Duong, Thai Nguyen, Vung Tau, etc. have been formed, improving the living standard of the people, and creating favorable conditions for domestic and international communication.

MAIN ACHIEVEMENTS OF THE GEOLOGICAL SECTOR

Besides the results of the consolidation and development of the geological sector to become a uniform system, with a numerous, multidisciplinary geological staff and diverse equipment and technology mentioned above, the achievements in geological investigation and mineral exploration over the last hundred years are great.

• ***Basic geological survey and research***

From the first publication by the French geologist on geology of Indochina (Amoux C., 1852) to further investigations on regional geology [5,12,13,42, Bourret, 1922; Dussault, 1921; Jacob, 1921; Patte, 1927; Hoffet, 1933]; on paleontology (Zeiller, 1903; Colani, 1920; Mansuy, 1908-1921; Fontaine, 1955, etc.), on petrochemistry [15], especially geological maps with scale of 1:2,000,000 (Fromaget, 1937, 1952), 1:500,000 and some maps at 1:200,000 and 1:100,000 scale, the French geologists had made initial important contributions to the geoscientific investigations in Vietnam. Through their research works they had drawn the basic features of the geological structure and the history of geological development of Vietnam. At the same time they also determine the basic types of mineral resources of the country. However, due to various objective and subjective reasons, those works could not avoid shortcomings or errors which have been and are being corrected.

Since 1945, especially since 1955, geological studies have been intensively developed. In the first stage we received multi-facetted assistance from the former Soviet Union and other socialist republics.

The basic geological and mineral resources investigations in Vietnam consisted mainly of survey and mapping, which is usually accompanied by mineral prospecting, expressed in the forms of geological maps, panned concentrate, stream sediment, mineral, geophysical, hydrogeological maps and other thematic maps.

- **The geological map of the North of Vietnam** at 1:500,000 scale and explanatory notes was compiled, with the assistance of former Soviet specialists with the Editor-in-Chief Dovjikov (1963-1965), together with pan concentrate and stream bed sediment maps of the same scale, laying an important landmark in the development of the geological sector. Similar maps compiled by Vietnamese geologists were completed for the South (Nguyen Xuan Bao, 1980), then were correlated and corrected for publication of the 1:500,000 scale Geological Map of Vietnam [45]. The explanatory notes to these maps on stratigraphy [52] and magmatism [10] were also published.

Shallow offshore geological survey was started only in 1991, with the compilation of the geological and mineral resources map at 1:500,000 scale and high resolution seismic, magnetic and radiometric geophysical survey of shallow offshore area from Mong Cai to Ha Tien.

During continuous 30 years from 1964 to 1994, the geological and mineral mapping associating with pan concentrate, geochemical and geomorphologic, Quaternary geology maps etc. at 1:200,000 scale was completed in 58 sheets covering the whole main land territory, of which 45 sheets have been published together with explanatory notes in Vietnamese, Russian or English.

Through the survey and compilation of the above maps, many stratigraphic, magmatic, metamorphic units, Precambrian and Phanerozoic structure-facial zones in Vietnam have been delineated and described with abundant scientific data and published in many works. At the same time, many new mineral occurrences have been determined and delineated, such as tin in Tam Dao, Quy Hop, Lam Dong, etc., rare, precious, base metals, industrial minerals etc., together with many geochemical, panned concentrate anomalies, serve as the basis for further geological investigation, prospecting and exploration.

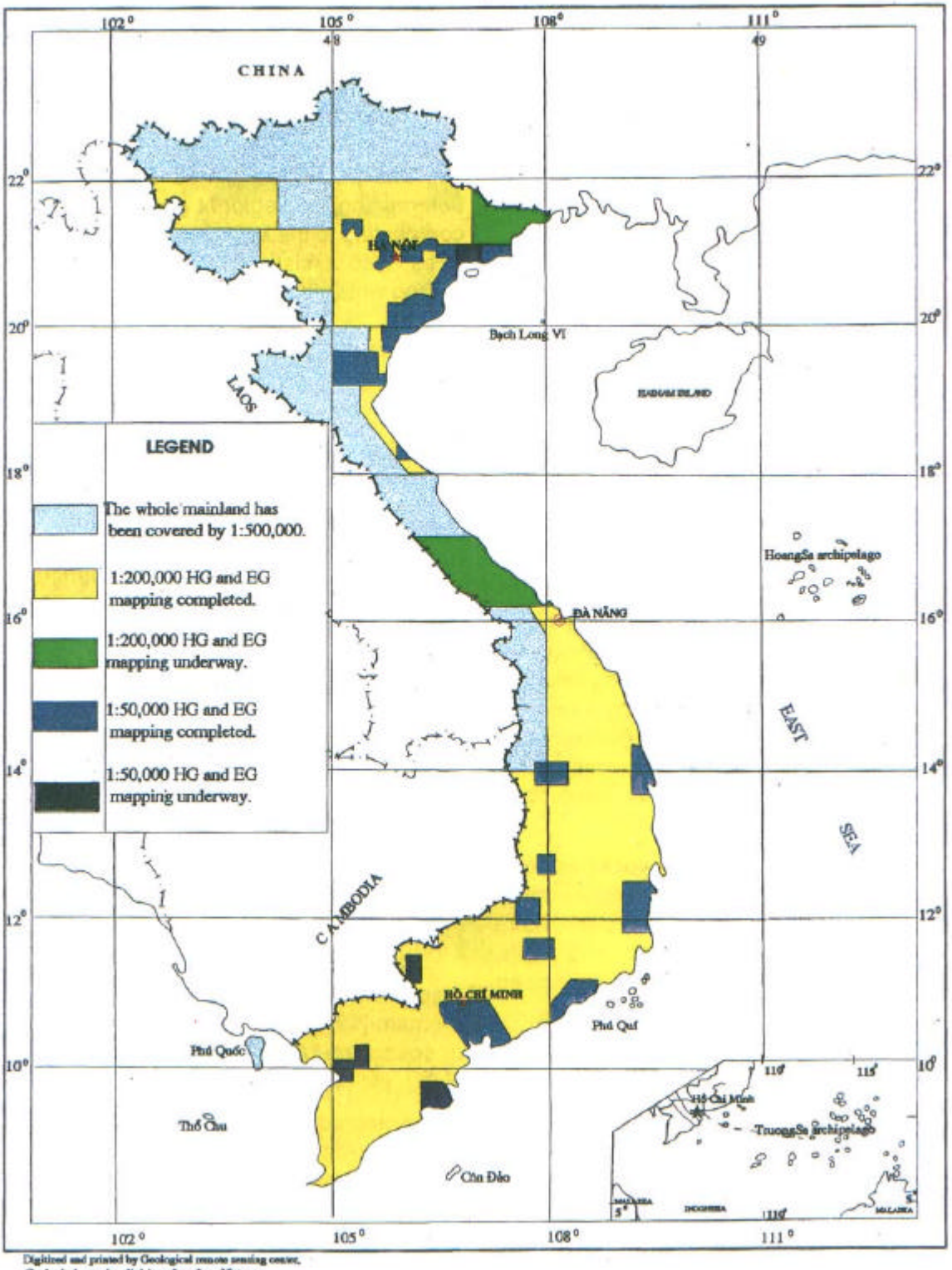
From the end of the sixties to present, the geological and mineral resources mapping work at 1:50,000 scale and compilation of accompanying special maps according to some strict regulations have been completed for about 200 sheets in many areas perspective in mineral and urban development, accounting for 30% of the territory (see Fig. 1). From these results, a series of new stratigraphic units have been established, new premises, indications have been discovered, and mineral prospective areas have been delineated.

- **Hydrogeological and engineering geological** mapping and evaluation of groundwater resources have been systematically carried out from 1962. The 1:500,000 scale hydrogeological map of Vietnam [47] has been published.

So far, 1:200,000 scale hydrogeological and engineering geological maps have covered nearly 60% of the territory, mainly the Bac Bo, Nam Bo plains, Central coastal plains, the Central plateau and part of the mountain and midland region of Bac Bo. Following are the hydrogeological and engineering geological maps at 1:50,000 (or 1:25,000) scale which have been compiled in nearly all urban areas and key economic areas accounting for nearly 10% of the territory (see Fig. 2). Besides, a national groundwater monitoring network has been established for Bac Bo, Nam Bo plains and the Central plateau with 611 monitoring points, of which there are 536 wells.

As a result of the above hydrogeological and engineering geological mapping work, the Cenozoic porous aquifers, especially those in the plains, as well as karst and fissure aquifers have been delineated and their groundwater resources have been estimated; at the same time

Figure 2. Status of Hydrogeological and Engineering Geological Mapping
at 1:25,000 to 1:500,000 scale



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the physico-mechanical characteristics of the soils and rocks in many areas have been described.

- Urban geology survey has been carried out since 1992. For major cities and towns, sets of geological, mineral resources, hydrogeological, engineering geological, geomorphology - Quaternary geology - neotectonic maps, geophysical field environmental geology and land use planning maps at 1:50,000 or 1:25,000 scale have been compiled.

- **Regional geophysical work** has been carried out from the early sixties. Airborne magnetic survey at 1:200,000 scale have been completed, surface gravity and radiometric survey at 1:500,000 scale have been carried out nearly for the whole country.

Airborne magnetic and gamma radiometric survey at 1:50,000 or 1:25,000 have been carried out on many mineral prospective areas, covering 22.5 % of the territory (see Fig. 3). Gravity survey at 1:100,000 scale has been also carried out in some areas [43].

As regards global geophysical work, 30 earthquake, geomagnetic field, ionosphere, radiation, etc. observation stations have been upgraded and built. Especially, an earthquake inventory of Vietnam has been established and initially the seismo-tectonic, paleomagnetic investigations and geomagnetic field of the equatorial area have been started with compilation of corresponding maps [25].

The above mentioned results, besides determining the regional geophysical fields, contributing to the investigation of deep structures, also assist in determining anomalies among which in particular Thach Khe iron ore deposit, Yen Phu rare earth deposit, Nong Son uranium deposit, etc., have been discovered, as well as in determining global geophysical characteristics of Vietnam.

- **As regards thematic research** in geology together with the results of basic survey many works by Vietnamese and foreign researchers have been published.

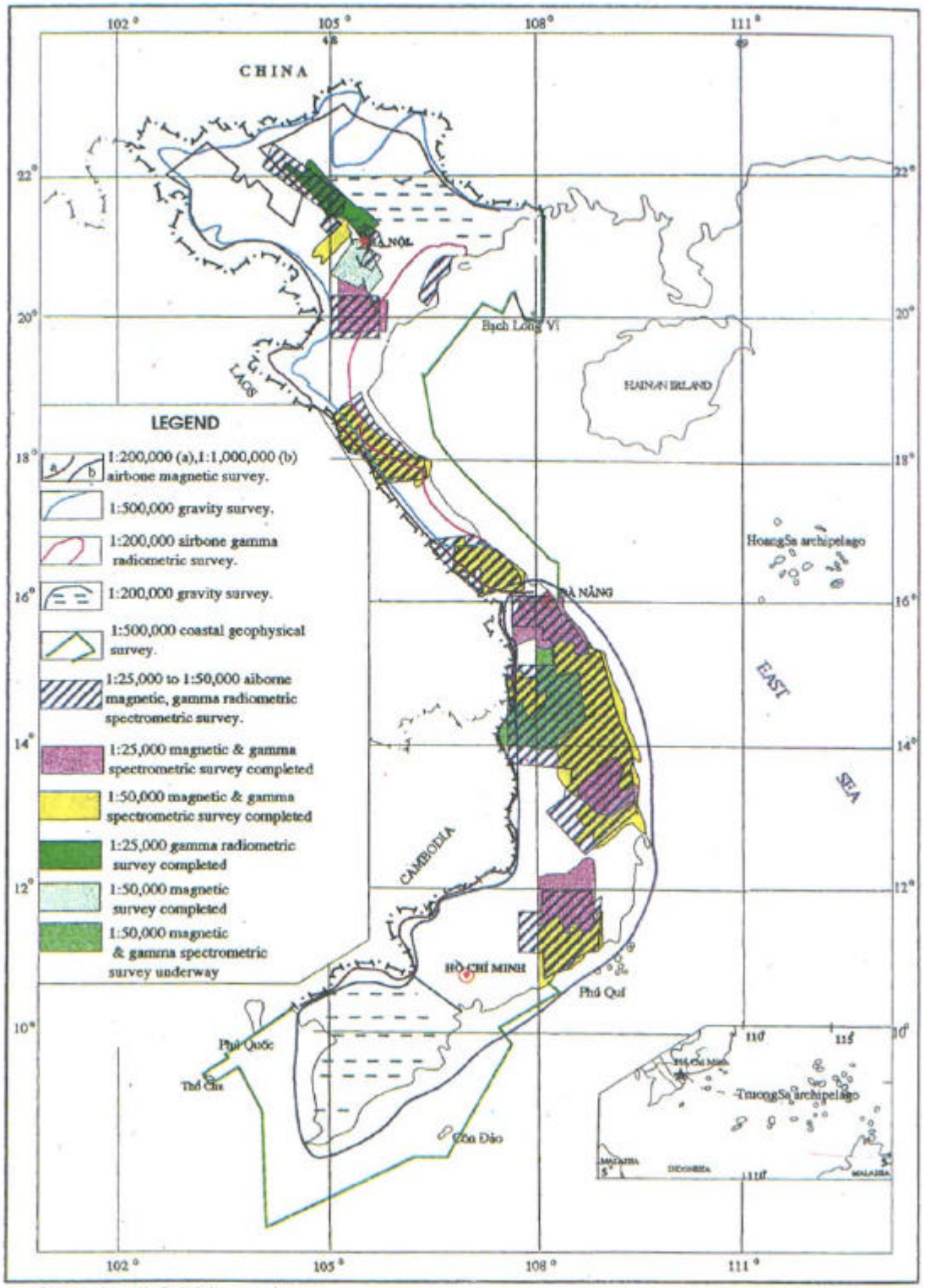
In stratigraphy, especially Phanerozoic has been divided [7, 9, 12, 52], of which many systems have been subdivided in detail down to stages, zone or formations, members such as Devonian [44], Carboniferous - Permian [33], Triassic [52], etc. As regards magmatic rocks, they have been subdivided into complexes with composition and forming cycles from Late Precambrian to Mesozoic [9, 15], etc. Later a general synthesis of the magmatism of Vietnam has been carried out [9, 10, 17, 36] and Precambrian metamorphic rocks [41].

Some integrated works on mineral resources of the North of Vietnam [19], of Vietnam [19, 21], general metallogeny [8, 29] or special metallogeny of tin, gold, lead-zinc [6, 11], etc., have been also published.

Autochtonous and allochthonous tectono-structural units which by lateral movement mechanism have created arcuate structures; drifting covers (called "charriages" by French geologists) such as Bac Ha, Song Da, etc. [5, 13]; geosynclinal structuro-facial zones [9] or plate tectonic geodynamic zones [19, 36] have been delineated and described.

Besides, a series of thematic studies on oil and gas [26, 50], geophysics [26, 43], geochemistry [28], geomorphology [18], Quaternary geology, hydrogeology, engineering geology, mineral water, thermal water [51], environmental geology, global geophysics [25], marine geology [24] have also obtained certain results. These results of thematic studies have been published in the country and abroad in the form of articles in journals, selections of research works of research institute, Geological Divisions, universities, proceedings of scientific conferences, seminars, or in monographs. They have contributed to the strengthening of the geoscience of Vietnam.

Figure 3. Status of Airborne Magnetic, Gamma Radiometric & Spectrometric Survey at 1:25,000 to 1:50,000 scale



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• ***Mineral prospecting and exploration***

For over the last half century, the geological sector has concentrated a large efforts and has discovered about 5,000 ore occurrences, carried out the prospecting and exploration of nearly 60 kinds of minerals, not only in old mines but also in many new ore-bearing areas and deposits, calculated the prognostic resources and reserves for each kind of minerals. (See Fig. 4)

- **Energy minerals:** Anthracite with good quality, distributed in Quang Ninh basin and partially in Nong Son basin, fat coal in Song Da basin, etc., have been evaluated with a total resource of over 10 billion tons and of which the evaluated reserve is 2.1 billion tons. Total output in 1997 reached 11.2 million tons. Lignite has been evaluated in many areas, especially it has been discovered at great depth in the Hanoi depression with potential resources of about 200 billion tons. Peat is found mainly in Nam Bo plain. Besides, oil shale is found in Dong Ho [19].

Although oil and gas was just discovered 20 years ago, its investigation has rapidly developed. Tertiary basins such as Song Hong, Phu Khanh, Cuu Long, Nam Con Son, Vung May, Malay - Tho Chu and groups of basins such as Truong Sa, Hoang Sa [26] have been delineated with total resources of about 5,000 million tons of equivalent oil [48] and with a reserve of 900 million of m^3 of equivalent oil, of which 290,000 million m^3 of gas in the Song Hong basin has high CO_2 content [27]. The output in 1997 was 10.1 million tons of crude oil. Especially oil pools in fractured basement rocks (granite, granodiorite) in Cuu Long basin with large potential, opening a new premise in petroleum geology [23].

- **Iron ore:** Of interests are discovery by geophysical survey and exploration of scarn iron ore deposit under the coastal plain in Thach Khe (Ha Tinh), with a reserve of 554 million tons, and some iron ore areas in Thai Nguyen, Yen Bai, Cao Bang, etc, chromite in Thanh Hoa, manganese in Cao Bang, nickel in Son La [20], tungsten, molybdenum, cobalt, etc., in some places have been also subjected to prospecting, exploration and exploitation. Coastal titanium placers are distributed in many places in the Central region and in gabbro in Thai Nguyen with a total resources of over 20 million tons.

- **Base metal ores:** Sin Quyen copper deposit (Lao Cai) was discovered at the end of the fifties. It has been explored, with a reserve of 551,000 tons of copper, together with associated metals such as gold, silver, rare earth. Besides, some copper ore areas and deposits in East Bac Bo and West Bac Bo have been also evaluated [19].

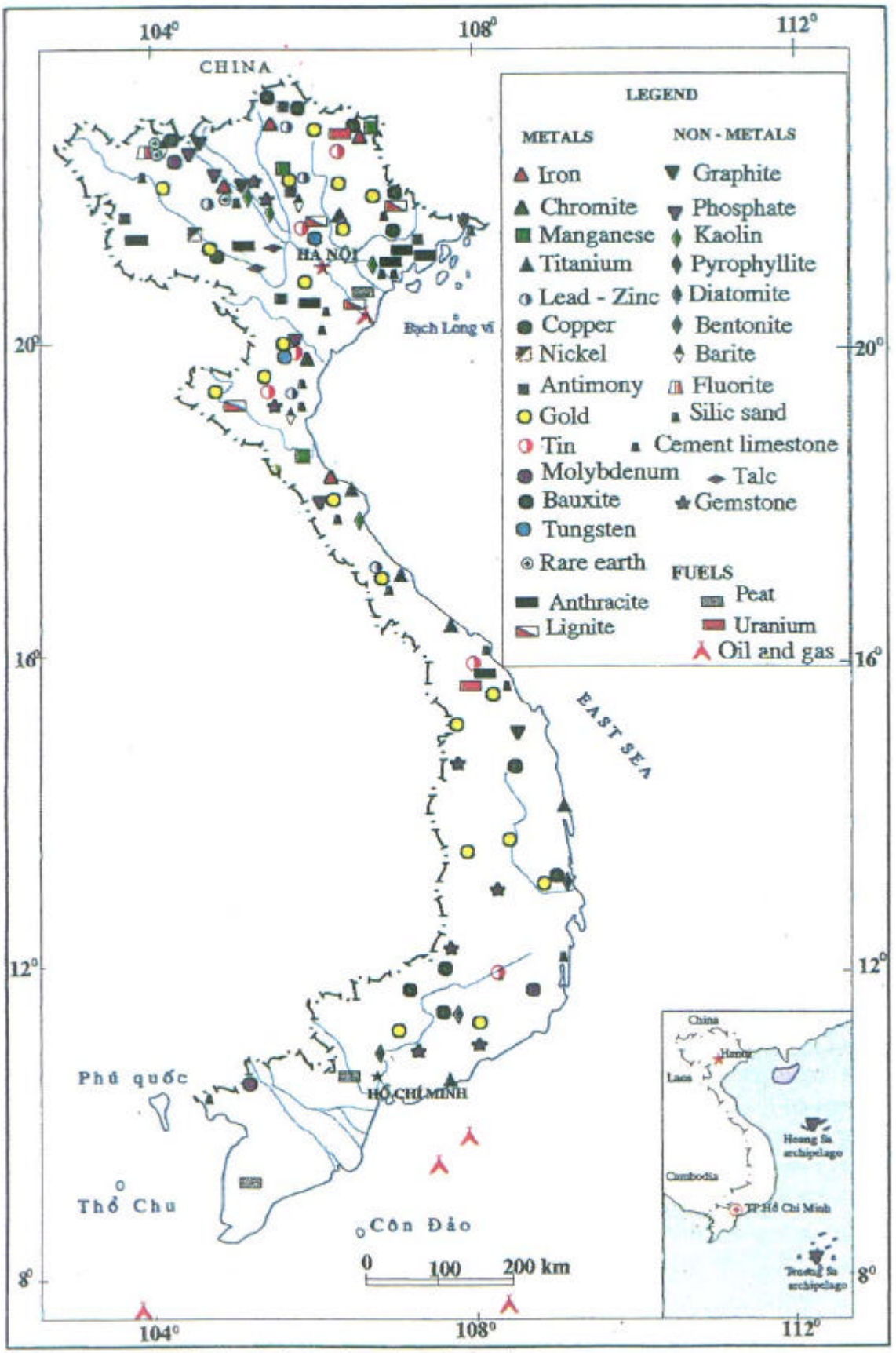
Some lead-zinc, antimony deposits in Viet Bac, Northeast, North Trung Bo, with medium size, many new tin deposits in Tam Dao, Quy Hop, Lam Dong have been discovered, many of which have put into exploitation.

- **Light metal ores:** After the liberation of the South, a series of laterite bauxite ore areas form from Cenozoic basalt in the Central plateau have been discovered [21]. Exploration has given over 500 million tons in the total resources of over 4 billion tons. Besides, Permian sedimentary bauxite in Viet Bac have been also explored [19].

- **Precious metal ores:** Gold has been discovered and investigated in many areas both in the North and the Central regions, where hydrothermal gold-sulfide or gold associated with copper, antimony ore, etc. in the form of primary, placer gold are common [11], with total prognostic resource of a few thousands tons. In the recent years many domestic and foreign companies have promoted gold exploration. Besides, paragenetic silver and platinum have also been discovered.

- **Radioactive and rare earth ores:** Have been discovered in many places, especially rare earth related with alkaline rocks in Lai Chau, Yen Bai, with world class resources and reserves, uranium in sandstone in Quang Nam with considerable resources [37].

Figure 4. Mineral Resources Map of Vietnam



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- **Gemstones:** Ruby and sapphire were discovered over ten years ago. They are being explored and mined in Yen Bai, West Nghe An, etc., and, through initial evaluation, have large resources [34].

- **Industrial minerals:** Phosphate ore in the form of metasedimentary apatite in metamorphic rocks in Lao Cai has been explored with a reserve of about 900 million tons and prognostic resource of up to 2.5 billion tons. Phosphate of infiltration, cave types in some areas and guano types in Truong Sa and Hoang Sa have been also investigated. Barite, fluospar, pyrite, graphite, talc, asbestos, muscovite, feldspar, magnesite, crystalline quartz, etc. have been investigated and evaluated with medium and small size.

Especially, cement limestone and dolomite with very large reserves; pottery clay, kaolin, pyrophyllite, diatomite, bentonite, silica sand, etc. have been explored and their reserves have been calculated to be of large and medium size.

Besides, construction materials of various kinds such as facing stone, sand, gravel, brick clay, etc. are being exploited in many localities throughout the country.

- **Groundwater resources:** Have been investigated since 1962. Large investment has been made for prospecting and exploration in important economic regions such as the Bac Bo plain, Nam Bo plain, the Central plateau, especially in major cities such as Hanoi, Ho Chi Minh city and many other urban areas. Totally nearly 150 areas have been subjected to prospecting with a total calculated reserve of nearly 3 million m^3/day which can serve the domestic water supply and the economic development, in a total resource of 20 million m^3/day. Recently, groundwater in mountain areas and in islands have also been investigated.

Besides, over 400 sources of mineral and thermal water sources have been discovered, of which over 270 sources have been investigated, 50 sources have been subjected to prospecting, exploration and exploitation, mainly for bottling, medical treatment and some thermal water sources are being considered to be exploited as geothermal energy sources [51].

- **Information, archiving, museum and library facilities:** The information system in many organizations are rapidly developed both in hardware and software, as preliminarily presented above.

In the geological archives at present about 3,000 reports are kept, of which 1,740 reports are on mineral prospecting and exploration, the remaining are on hydrogeology, engineering geology, geophysics, geological mapping and thematic research works. The geological library at present contains over 46,000 books and journals, of which there are 131 titles of journals in various languages such as Vietnamese, Russian, English, French, Chinese, Japanese, etc.

The geological museum in Hanoi has been upgraded. At present there are about 20,000 specimens belonging to over 200 collections, consisting of minerals, rocks, ores, fossils and other specimens. In the geological museum in Ho Chi Minh city nearly 10,000 specimens are being kept. Besides there are a dozen stores keeping about 400,000 samples of various kinds including core samples collected during the survey, mapping, prospecting and exploration in the past 40 years.

• ***International cooperation***

With the great and multifaceted assistance from the former Soviet Union and other socialist countries during the period of centrally planned economy, the geological sector has set up the initial bases and has rapidly developed. However, due to the old mechanism, the efficiency is still limited.

The cooperative relationships with Laos and Cambodia have been developed for decades in various activities from exploration of coal, rock salt, gypsum to compilation of geological maps, training of staff.

Since the adoption of the renovation policy, the international cooperation, joint venture, foreign investment in geological investigation, mineral exploration and exploitation have been developed with hundreds of projects in various forms with various countries such as Russia, France, Japan, Korea, China, Australia, Belgium, UK, USA, Canada, India, New Zealand, ASEAN, and North European countries. Besides, UNDP, ESCAP, CCOP have extended their cooperation and assistance in various aspects. As regards foreign joint venture and investment, so far the State has granted over 400 prospecting, exploration and mining licenses, of which 34 petroleum contracts have been and are being implemented.

The Geological Association of Vietnam is a member organization of IUGS. Many organizations or geologists are members of CPCEMR, international specialized associations in geophysics, geochemistry, hydrogeology, engineering geology, tectonics, stratigraphy, and other disciplines, or participate in projects of IGCP. Recently the geological sector of Vietnam has joined GEOSEA.

As a results of the cooperation and participation in the above fields, the geological sector of Vietnam is approaching the regional and international integration for development.

With the achievements obtained in the last over 50 years, the geological sector has been awarded by the State with the Ho Chi Minh Order, many organization and individuals have received over 660 orders of various kinds, nearly 10,000 Medals "For the Cause of Geology of Vietnam" and many other noble rewards.

This paper has been completed with the help of many colleagues. The author expresses his thanks and recognizes that with the geological activities during the last hundred years, many events and achievement have not been mentioned here. The author wishes to receive supplement and corrections.

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Lao Cai Phosphate mine

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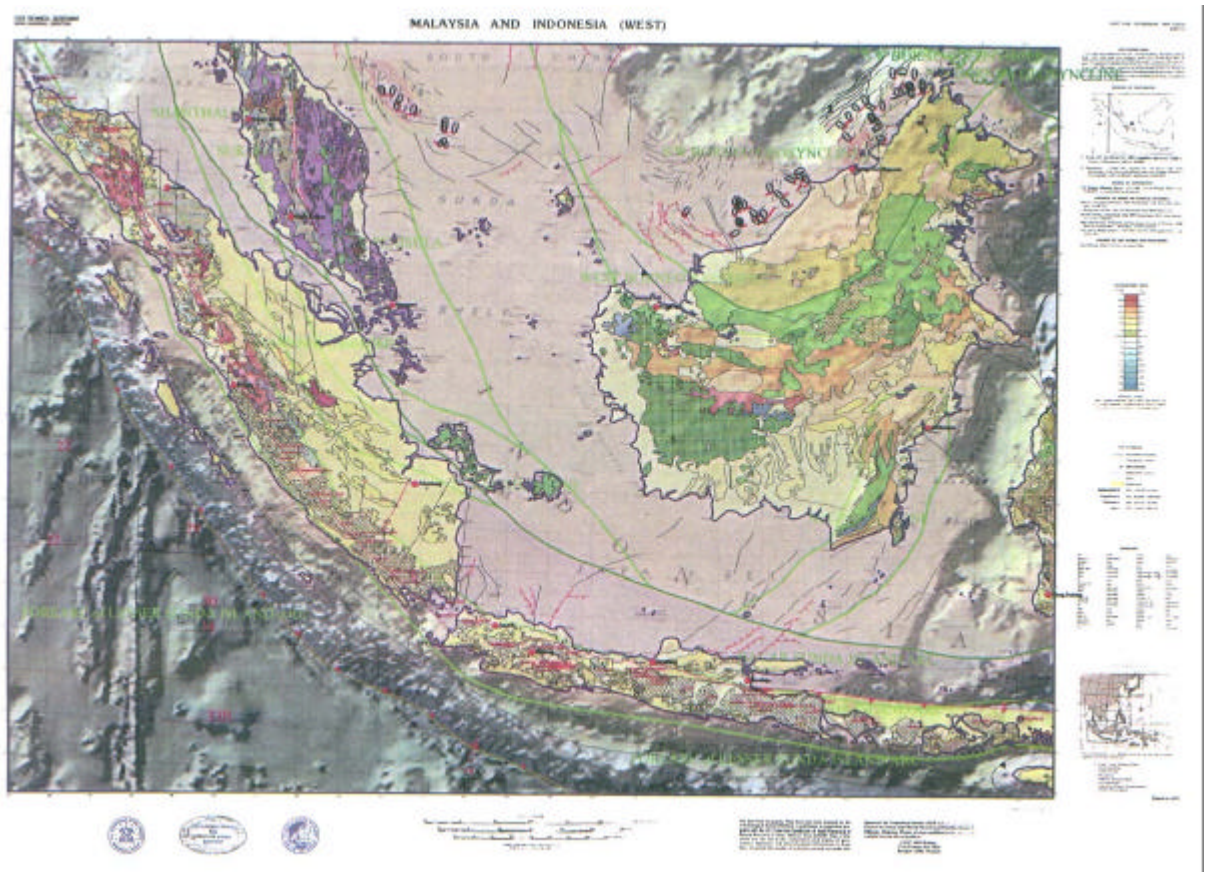

General view of Sheet 5 of Geotectonic Map of East and Southeast Asia

The colour for each unit is assigned by its age range, while the pattern is specified by its tectonic type.

Red (and black) lines with and without sawteeth show active (and inactive) plate boundaries, faults and fracture zones.

Green lines indicate tectonic unit boundaries. The name of each tectonic unit is also shown in green colour.

Red lines with numbers show seafloor spreading magnetic anomalies.

Red circles show active volcanoes.

(After Sato, Okumura, et al,., 2000. See an introductory article on p.2-3 in this newsletter.)

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