

ANNUAL COUNTRY REPORT OF JAPAN: 2002

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ANNUAL COUNTRY REPORT

Member Country: JAPAN

Period: 2002

GEO-RESOURCES SECTOR (Minerals, Energy and Groundwater Programmes)

1. MINERALS PROGRAMME

Summary

The stable supply of mineral resources for domestic needs is an important part of the national policy of Japan for the sustainable development of basic industry and high standard of living. Nonferrous metals including base and rare metals are essential for our daily lives and various industries including telecommunications, electrical appliance, automobile, and construction.

Japanese government issued a policy for future mineral supply in March 2000. The government encouraged further improvement of technologies related to mineral exploration, mining, smelting, processing, recycling and mitigation of environmental pollution. These technologies are important for the Japanese nonferrous metal industries' ability to cope with the changing conditions in mining development. Under the policy of the Mining Division of the Ministry of Economy, Trade and Industry (METI), the Metal Mining Agency of Japan (MMAJ) is executing the FY 2002 plan; domestic and overseas mineral exploration, financial assistance for Japanese mining companies, stockpiling of rare metals, technological research and developments and pollution control related to mining activities.

Domestic Exploration

The domestic mineral exploration program by MMAJ consists of regional and detailed geological surveys, including geochemical, geophysical and drilling and tunneling surveys. The regional and detailed geological surveys in FY 2001 covered four districts (northern Hokkaido, southern Hokkaido, Middle Tohoku and Hokusatsu-Kushikino in southern Kyushu) and two districts (southern Hokkaido, and Hokusatsu-Aoki in southern Kyushu), respectively. One of the most important targets in the southern Hokkaido district is a high-grade base metal mineralization within the Toyoha-Muine hydrothermal system of Pliocene to Pleistocene age. MMAJ conducted two exploration drillings in the southern area of the known vein system of the Toyoha mine and revealed further extension of base metal mineralization to the eastern and southeastern directions.

Overseas Exploration

The overseas mineral exploration of MMAJ started in FY 1970 as a technical cooperation for mineral

exploration in developing countries. In FY 2001, MMAJ carried out 18 overseas projects for mineral exploration in over 17 countries including six Asian countries as shown in Table 1.

In addition to MMAJ activities, Japanese mining companies have been conducting overseas projects as follows.

Sumitomo Metal Mining Co. and Teck Corporation Canada are jointly executing an exploitation project on a mesothermal gold deposit at Lisa, Stone Bay, Alaska which was discovered by a MMAJ project between FY 1994 and FY 1996 (support of exploration for mineral resources by private companies). The project is in the last stage before operation, and they have requested permission for the project to the Environmental Protection Agency, USA. Sumitomo Metal Mining Co., Nissho-Iwai Co. and Benguet Corporation jointly started an exploration project for a Ni-bearing laterite deposit at Zanbales, Philippines. Sumitomo Metal Mining Co., Santoy Resources Ltd. and Fairfield Mineral Ltd. started a joint project for exploration of a Cu-Au-Pt mineralization in Tropic, Sinaloa, Mexico.

Dowa Mining Co. and Rio Tinto Co. continued a joint exploration project for massive sulfide deposits in Spain and Portugal (Iberian Pyrite Belt). Dowa Mining Co. and Inco Co. continued a joint exploration project for massive sulfide deposits in northern Turkey.

Nittetsu Mining Co. received the exploration right and started an exploration project for a high-grade hydrothermal mineralization in the vicinity of large-scale but low-grade porphyry Cu-Au deposit of Waiso, Namosi, Viti Levu in Fiji. They successfully identified significant enrichment of copper by drilling. Nittetsu Mining Co. also completed 71 drill holes on a survey for the exploration of porphyry copper deposits and started to construct mine facilities of the Atacama Kozan mine, Tierra Amarilla area, 3rd State, Chile. They also received an exploration right (500 km²) in middle to northern Chile and started geological survey and geochemical exploration for porphyry copper deposits.

Scientific Research Activities for Mineral Resources of AIST

GSI/AIST is responsible for the research part of the exploration of mineral resources. The Mineral and Fuel Resources Department (now reformed into Institute for Geo-Resources and Environment after FY 2001) has conducted a wide range of research works with mineral resources analysis, ore genesis and exploration methods for metal and non-metal resources. The Department is recently expanding its scope to the problems of pollution control in mining activities.

As for the resources analysis, GSI/AIST has accumulated basic data on mineral resources and been publishing compiled metallogenic maps of Japan (1:500,000 map series). During FY 1995-2001, five sheets, the northern islands of Hokkaido 1 and 2, Tohoku area, Kanto area and Chubu and Kinki area of Honshu Island have been published. Two sheets, Chugoku area of Honshu and Shikoku Islands and Kyushu Islands are being published in FY 2002. As a part of resources analysis, compilation of geological information was made for the whole country to help plan future aggregate production. The resulting publication is expected to help both local governments and companies plan strategic development of crushed rocks. Concerning research works for technical innovation in the exploration of blind deposits, GSI/AIST has been conducting geological, geochemical and geophysical surveys to reconstruct the entire structure of an extremely metal-rich deposit within the active volcanic hydrothermal system of

Toyoha-Muine in southern Hokkaido. This is a case study to test their latest understanding of the hydrothermal ore genesis and improve their capability to explore blind hydrothermal deposits mostly concealed by a younger volcanic succession. It is expected that the research results will be applied for other countries under similar geological environments.

Also, GSJ/AIST started research cooperation programs with Russian Academy of Sciences and MTA Turkey, in which they aim to exchange scientific information on hydrothermal ore genesis for better exploration and exploitation of large-scale blind deposits as well as stressing the minimization of the environmental impact of surface exploitation. They also commenced research cooperation with the Korean Institute of Geology and Mineral Resources (KIGAM) on the genesis of bentonite deposits.

Table 1. Achievements of Technical Cooperation for Mineral Exploration by MMAJ in FY 2001

Country Area Name	Type of Ore Deposit	Results
Indonesia Eastern Java	Porphyry type	Identified 4 areas as promising targets for Au and Cu exploration
Brazil Alta Floresta	Green stone belt type vein deposit (Au, Ag)	Discovered small-scale gold mineralization along shear zones
Brazil Parana Basin	Flood basalt type (PGE, Cu, Ni)	Identified the feeder zone and distribution of basalt flow based on satellite image analysis and field survey.
Mongolia North central area	Porphyry type (Cu, Mo, Au)	Indicated the following areas as promising targets for porphyry copper mineralization: 1. Areas structurally connected with Erdenet deposit by fault system, 2. Areas where different fault systems intersect to each other. 3. An area of magnetic-low anomaly possibly develops over an intrusive body.
Argentina Northwestern area	Porphyry type and related epithermal type (Cu, Pb, Zn, Au)	Surveyed 26 sites and evaluated mineral potential focusing on epithermal gold and porphyry copper type mineralization
Philippines Northern Bicol	Epithermal (Cu, Au)	Indicated seven promising areas for epithermal mineralization
Bolivia Oruro-Uyuni	Epithermal (Au, Ag, Cu, Pb, Zn)	Identified no significant mineralization by drilling in spite of wide-spread hydrothermal alteration at the surface
Chile 1st State	Porphyry type (Cu, Mo, Au)	Indicated several promising areas for porphyry type and associated epithermal mineralization.
China Altai	Massive sulfide (Cu, Pb, Zn) Orthomagmatic type (Cu, Ni)	Indicated the deeper part of the Altai mine and surrounding area of known Cu-Ni mineralization of Karatongke as promising areas for massive sulfide and orthomagmatic deposits, respectively
Kazakhstan Kokpektinskaya	Placer (Ti)	Evaluated the reserve of two ilmenite ore bodies at Bektimir to be 680 kt (132 kg/m ³) and 390kt (131 kg/m ³) .
Mali Baoule-Banifing	Green stone belt type vein deposit (Au, Ag)	Discovered a Au-bearing quartz veins (1m thick, 9.6 g/t, and 15 cm thick, 138 g/t) in Diarm
Honduras Southwest to central area	Skarn type (Au, Ag, Cu, Pb, Zn)	Indicated the Higuero Morado and Cedros areas as promising targets for skarn type and epithermal mineralizations
Peru Southern area	Porphyry type etc. (Cu, Pb, Zn, Au, Ag)	Indicated five promising sites for further exploration: Calhuahuacho area for a stratiform Cu Livitaca area for a skarn-type Cu, Ag Macsani area for a vein-type Sn, Cu Usicayos area for a dissemination-type Sn, Cu, Pb, Zn Vilque area for a vein-type Ag
Uruguay San Jose-Arroio Grande area	Green stone belt type (Au)	Indicated six areas as promising targets based on cropped out quartz veins, geochemical anomaly and airborne geophysical data.
Tunisia Kuripmejez-Elbab area	Mississippi Valley type (Pb, Zn)	Discovered the zone of Pb-Zn mineralization (12 m thick in total, Pb = 1.55%, Zn = 12.1%) in the El Akhouat area
Oman Yankil-Guzain	Massive sulfide (Cyprus type)	Discovered significant mineralization (12 Mt, Cu=0.7%) in the Quron Al-Akhabab area
Vietnam Dong Pao	Alkalic igneous complex (REE)	Evaluated the vertical and horizontal extension of the known REE deposit at Dong Pao, northern Vietnam, and concluded it had a high possibility of exploitation.
Mexico Zacualpan	Massive sulfide (Zn, Pb, Au, Ag)	Identified the ore horizon to be between the volcanic rocks of upper Jurassic to lower Cretaceous age and overlying argillaceous/calcareous sedimentary rocks.

2. ENERGY PROGRAMME

2.1. Oil and Gas

Domestic Exploration

The Niigata, Tohoku and Hokkaido Regions are the main oil and gas fields in Japan. In FY 2001, a basic government drilling was undertaken (total depth (TD); 5,200 m) on the onshore Chikappu Structure, west of Wakkanai City, Hokkaido, following the drilling in FY 2000. Three Drill Stem Tests (DSTs) in the Cretaceous and upper Tertiary Structures were carried out, and small amounts of gas and water were produced.

Japan Petroleum Exploration Co. (JAPEX) drilled at four sites. Although in the Niigata Prefecture two onshore drill holes reached green tuff beds of Miocene age, they did not confirm the commercial amount of oil and gas. In the southern part of Iwafune-Oki oil and gas field off the Niigata Prefecture, the MS-1 well was drilled (TD; 4,120 m). Three DSTs were carried out to confirm 76.2 kl/d oil and $173.2 \times 10^3 \text{ m}^3/\text{d}$ gas production.

In Akita Prefecture, the SK-1D (TD; 2,108 m) well was drilled onshore, where four DSTs were carried out. The No. 2 DST well on the Onnagawa Formation and the No.4 DST on the Funakawa Formation produced oil and gas. The DSTs produced crude oil of 95.2 kl/d and natural gas of $115.2 \times 10^3 \text{ m}^3/\text{d}$, and the structure is expected to develop in future.

JAPEX also undertook a geophysical survey in two regions. In the southern part of Hokkaido, an MT (define MT) with 20 observation points was carried out to identify the deeper part of the geological structure. Around Tomakomai City, onshore in the Hokkaido region, a seismic survey with a total line length of 26,000 m was carried out in order to elucidate the deep structure. JAPEX, Japan Energy Co. and Nisseki-Mitsubishi Oil Development Co. carried out a marine air-gun seismic reflection survey south of Tomakomai City with a total line length of 1,034 km.

Overseas Exploration

Japanese companies are exploring for and exploiting oil and natural gas in Norway, Caspian Sea, Southeastern Asia and Australia.

A joint company of the Idemitsu Oil Development Co. Ltd. and Idemitsu-Norre Oil Development Company found a new oil field in the southern part of PL089 lot in the North Sea. The company can take 9.6% of the production rights and interests equivalent to $36 \times 10^3 \text{ m}^3/\text{d}$.

In Caspian Sea, a subsidiary of Mitsui Oil Exploration Co., Ltd. (MOECO) drilled an exploration drill off of Azerbaijan. Japanese, European and American companies jointly participated in an exploration and development project off of Kazakhstan. They confirmed production rates of 3397 bbl/d at the Kashagan West-1 well and 7,400 bbl/d at the Kashagan East-2 well.

Offshore of Thailand, the MOECO drilled three evaluation wells at Blocks 10–13, an evaluation well at Block 10/32 and another well at Block 10A/11A. A MOECO subsidiary, Thailand Offshore Co. Ltd. is drilling two evaluation wells in the Pailin gas field of Block 12/27. Another subsidiary, MOECO

Thailand, drilled 15 test and evaluation wells in 14A/15A/16A oil concessions.

In Vietnam, MOECO-Southwest Vietnam and MOECO Vietnam, drilled four test wells in the oil concession of 52/97 and B western offshore of Vietnam.

In Indonesia, MOECO Sarawak drilled a test well "NWO-1" in Irian Jaya. INPEX and French TOTLFINAELF companies received a new Donggala oil concession near Makassar Strait.

Recently, INPEX Co., Idemitsu CO., Mitsui Oil CO., Cosmo Oil Co. and their group company began developing the continental shelf west, northwest and north of Australia. All of them have found good indications of oil and gas around Australia.

Scientific Research Activities of AIST

Since FY 2000, AIST has undertaken three research projects on:

- (1) Hydrocarbon potential originated from coal
- (2) Methane hydrate
- (3) Genesis and formation of a natural gas reservoir

In the first project, GSJ/AIST and Japan Energy Co. jointly reevaluated the hydrocarbon potential in the Cretaceous and Paleogene sediment formations offshore of the Sanriku region. The hydrocarbon potential of the onshore coal beds of the same age was preliminary analyzed from the viewpoint of organic geochemistry and coal characteristics.

In the second project, a study on basic genesis and exploration of methane hydrate were carried out mainly in accretionary prisms in the eastern part of the Nankai Trough. A 2D/3D seismic reflection survey, subsurface profile survey and direct observation of the sea bottom were undertaken by Shinkai 2000 and Shinkai 6500 submersibles. These studies have contributed to the evaluation of the methane hydrate resources potential in Japan. In addition to these surveys, AIST attended the resource evaluation program of Arctic onshore hydrate in the Mackenzie Delta, cooperated with JNOC, USGS and Canadian Geological Survey.

As a part of the methane hydrate research, AIST had started the development of a numeric simulator to estimate the methane hydrates dissociation behavior in sediment layers and gas production behavior thorough production process at a field scale since FY 2001. The research is necessary to evaluate the methane hydrate deposit and examine the feasibility of hydrate exploitation. Now we have developed numerical computation models that predict methane hydrate dissociation behavior in sediments on a laboratory experiment scale and gas production simulators, which incorporate simplified methane hydrate properties, on a field scale. However, these models and simulators have not reached such a level that they can describe adequately real physical phenomena on a field scale. The simulator, which is to be developed, will be applied under various operation conditions using the techniques of generally applicable numerical analysis and by comprehensively interpreting extensive data of basic properties, laboratory production tests, geophysical exploration and well logging analysis.

In the third project, natural gas, condensate and crude oil from green tuff in a representative oil and gas area and sediments of a hydrocarbon deposit were analyzed for stable isotopes to determine the organic geochemical factors. The result of the study elucidated that these factors were derived from biological

materials (kerogen). It also showed that natural gas from lower beds is thermogenic, while the archaeal contribution becomes larger in natural gas from upper beds. Various kinds of analyses of gas from water-dissolved natural gas fields and associated water in the southern Kanto region and Niigata Prefecture indicated that the methane was formed through CO₂ reduction.

2.2. Coal

Summary

Identified reserves of coal resources in Japan were estimated about 8,277 million tons (including lignite) by the 1998 World Energy Congress. But economically and technically recoverable coal reserves were assumed to be 785 million tons. Major coalfields are located in Hokkaido and Kyushu. Private coal mining companies had been producing all the domestic coal. In January 2002, Taiheiyo Coal Mine in Kushiro, Hokkaido, which had been the only large coal mine operating in Japan. Its commercial production was stopped because of coal producing costs. The other large coal mine, the Ikeshima Coal Mine in the Sakito/Matsushima coal field in Kyushu, had already been closed in 2000. The coal production is still continuing at the Taiheiyo Coal mine, annually less than 1 million tons, for the purpose of technical transfers to engineers from developing countries. Coal demand in Japan is more than 140 million tons, but domestic 2002 production will be limited to less than 2 million tons including small-scale open-pit mines.

Coalification occurred mainly during the Tertiary period. Coal seams accompany numerous faults, folding and partings due to intensive tectonic movements during the coalification period. Therefore, there is bituminous coal in Japan. In spite of younger depositional ages, there is sub-bituminous coal and small amounts of anthracite. However, underground coal mining operations need much more advanced technology than open-pit coal mines. Underground coal production faced difficulties of exploitation in deep tunnels and long transportation distances from the working face to the mine mouth. The mining depth has become increasingly deeper and has reached more than 800 m. Also, large volumes of water and methane are characteristics of coal mines in Japan. Methane gas production in coal mines reached 9.6 million cubic meters in 1999.

Scientific Research Activities for Coal of AIST

Major research activities of AIST for coal are on material science and depositional environment of coal. Analyzing coal properties controlled in the sedimentary environment is important for strategic coal exploration and utilization. Now new research works on the technology for CO₂ sequestration with a coal seam was started since 2001 on a national scale. AIST is preparing for a new project on site surveys to evaluate the best place for CO₂ sequestration with coal seam. Their data on coal geology should contribute to these projects. Other research works of AIST related with coal are coal petrographical and geochemical studies for oil originated from coal.

Through international cooperation, AIST intends to extend these research subjects to East and Southeast Asia countries having high potential for coal.

International Cooperation

JICA, Japan International Cooperation Agency, executed a three-month group-training course of coal mine technology, 2002 cooperated by AIST. Nine overseas participants including CCOP member countries successfully learned the Japanese way of coal mining technology and coal mine safety technology in the course.

2.3. Geothermal Energy

Summary

Geothermal energy is domestically available and also contributes to environmental protection on a global scale. Japanese islands are situated on the volcanic belt that encircles the Pacific Ocean containing many potential associated with Quaternary volcanoes. Some of geothermal fields have been exploited for electric power generation and direct heat supply. Currently, 17 geothermal power stations are operating with a total capacity of 546.9 MWe and produced 3,348 GWh in 2000. Japan is the sixth most abundant in total geothermal power generation in the world. As for direct use, Japan has a much greater use for hot-spring bathing than uses for space heating, agriculture, aquaculture, snow melting, tourism, stockbreeding and other industries. The installed capacity excluding hot-spring bathing amounted to 270.40 MWt in 2001.

Technological Development

The New Energy and Industrial Technology Development Organization (NEDO) is conducting two research and development (R/D) projects for geothermal exploration and utilization technologies. These two R/D projects consist of “Development of Hot Dry Rock (HDR) System” and “Development of Technology for Reservoir Mass and Heat Flow Characterization”. The long-term flow test in the Hijiori NEDO HDR field began in November 2000. From a technical viewpoint, AIST supports this project. AIST has also technically supported the development of technology for reservoir mass and heat flow characterization. The purpose of this project is to characterize and forecast the mass and heat flows which occur in geothermal reservoirs during production through reservoir monitoring such as gravity, resistivity, self-potential (SP), seismic etc.

Geothermal Energy Exploration and Development

NEDO has been undertaking a “Geothermal Development Promotion Survey” since 1980. The purpose of this project is to encourage the private sector to develop geothermal power plants by reducing the cost, risk and lead time for development. More than 40 areas have been surveyed. NEDO is also carrying out more detailed surveys to accelerate the construction of power stations by private companies. In FY 2001, these surveys were carried out in Shiramizu-goe (Kagoshima Prefecture), Appi (Akita Prefecture) and Eboshi-dake (Kagoshima Prefecture).

The detailed exploitation surveys were also conducted on promising areas by the private sector.

Several power stations have been constructed in the last decade in the following regions: Sumikawa (50 MW); Uenotai (28.8 MW); Yanaizu-Nishiyama (65 MW) in northern Japan; Hachijojima (3.3 MW) in central Japan; Takigami (25 MW); and Ogiri (30 MW) in Kyushu.

Scientific Research Activities for Geothermal Exploration of AIST

In FY 2001, AIST carried out basic research with NEDO to support a project of “Development of Technology for Reservoir Mass and Heat Flow Characterization”. The goal of the project is to improve reservoir-monitoring techniques and develop associated mathematical modeling technology involving geophysical surveying techniques.

A digital geothermal resource map on a scale of 1:500,000 for the Tohoku and Kyushu areas was published as CD-ROM version in 2002.

A geothermal heat pump is a new style of geothermal heat utilization. AIST has just started a basic geological study to support such demands.

International Cooperation

AIST conducted the “Research Cooperation Project on the Exploration of Small-scale Geothermal Resources in the Eastern Part of Indonesia” jointly with DGGMR and NEDO from 1997 to 2002. This project is for the development of exploration technologies that are appropriate for geothermal resources development on the remote islands in Indonesia. It is expected to contribute to the “Rural Electrification Program” of the Indonesian government.

The new IEA Geothermal Implementing Agreement (GIA) became effective in March 1997 as an international cooperation in geothermal R&D. As part of GIA, the three projects, Annex I- Environmental Impacts of Geothermal Energy Development led by New Zealand (Operating Agent - IGNS); Annex III - Hot Dry Rock; and Annex IV - Deep Geothermal Resources led by Japan (Operating Agent - NEDO) were started. Additional two Annex Projects, Annex VII: Advanced Geothermal Drilling Techniques and Annex VI: Geothermal Power Generation Cycle were approved as new Projects in 2001 and 2002. Annex V: Sustainability, Annex VIII: Direct Use of Geothermal Energy, and Annex IX: Geothermal Market Acceleration are still being reviewed and discussed among the members. The first stage of Annex IV was finished and the outcome of the Annex was compiled on a CD-ROM by NEDO. The operating agent of Annex IV was changed from Japan/NEDO to Germany.

Under the CCOP framework, AIST is leading a research project for “Geothermal Resources Database for East and Southeast Asia”. The First Compilers’ Meeting was held in Bangkok, Thailand on April 24-26, 2001, and the Second Compilers’ Meeting was held in Manila, the Philippines on February 5-7, 2002. The project is expected to be finished in March 2004 with three priority products: 1) CD-ROM and Internet website; 2) CCOP technical bulletin; and 3) Printed maps. In-house training and meetings of the national compilers are scheduled between 2002 and 2003 to achieve the objective of the geothermal database formation. Based on the “Available Data Sheet” submitted by the national compilers, all members started to discuss the implementation plan for the project’s goal.

3. GROUNDWATER PROGRAMME

Under the CCOP framework, the GSJ/AIST is leading a research program for "Groundwater Resource Database Project in East and Southeast Asia". The 1st Compilers Meeting was held in Bangkok, Thailand on April 24-26, 2001, and the 1st Workshop was held in Beijing, China in November 2001. The 2nd Workshop will be held in Taejong, Korea in February 2003. The project is expected to finish in March 2004 with the following products; (1) Establish the web site for the database, (2) Release note for the database (including Manual with CD-ROM) and (3) Publish the results in the Technical Bulletin of CCOP. All compilers are working on the data collection according to the data-format and making effort to achieve the goal of the program.

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GEO-ENVIRONMENT SECTOR (Coastal Zone, Geohazards and Environmental Geology Programmes)

1. COASTAL ZONE, GEOHAZARDS AND ENVIRONMENTAL GEOLOGY PROGRAMMES

1.1.Coastal Zone Management

The Geological Survey of Japan/AIST conducts research projects not only in geology, but also physics, chemistry and biology. Now, a new measurement system of sea grass standing crop using an underwater video camera is being developed for future use to define empirical relationships. The project is supported by the Ministry of Environment for FY 2000-2002. Ishigaki Island contains various types of sea grass beds whose flora have been recorded, but the standing crops of sea grass have been left unknown. Extensive field measurements of the standing crop will be used to define empirical relationships with imagery from the underwater video. The results of the standing crop will be mapped and synthesized in a Geographical Information System. Other research themes are dynamic sediment process, sediment facies, sequence stratigraphy, human impacts and the influence of the sea-level rise in representative deltas in the Asian region, which are particularly focused on Asian deltas; Chao Phraya, Song Hong, Mekong, Changjiang and Huanghe. There may be a new project, in the International Geological Correlation Program (IGCP), entitled "Deltas in the Monsoon Asia-Pacific Region (DeltaMAP): Late Quaternary Development and Recent Changes Due to Natural and Human Influences". In October 2002, Dr. Steve Goodbred (USA) and Dr. Yoshiki Saito (GSJ/AIST) will propose this project, which will run from 2003-2007.. The major goals are to 1) clarify the Late Quaternary history and correlate the stratigraphy of MAP river-delta systems, 2) determine the major geological controls and system responses for MAP river deltas, 3) reconstruct stratigraphic records of MAP-regional paleoenvironmental conditions, 4) constrain modern fluviodeltaic processes and material fluxes in MAP region, 5) identify impacts of anthropogenic forcings on MAP river and delta systems (i.e., irrigation, damming, land use) and 6) recognize major geohazard potentials for possible mitigation strategies. All CCOP-related countries are invited on this project. Please contact Dr. Saito <yoshiki.saito@aist.go.jp>.

International cooperation

The GSJ/AIST started a joint research program with the Department of Geology and Minerals of Vietnam (DGMV) on Deltas in Vietnam from 2001 for three years. The project focuses the Song Hong

(Red River) delta and Mekong river delta from viewpoints of stratigraphy and delta evolution since the last glacial maximum. In November 2001, four drill cores were taken from the Song Hong delta and two seismic surveys were conducted in canals and main channels of the Mekong river delta in February-March and April-May 2002.

The GSJ/AIST conducted a joint study for the past and present sea-level changes in Thailand from 1997 to 2000. Some new findings were presented at the International Symposium on the Geology of Thailand that was organized by the Department of Mineral Resources (DMR) of Thailand held in Bangkok on August 26-28, 2002.

1.2. Geohazards

Volcanic Eruption

GSJ/AIST is conducting studies on the formation process and eruption mechanism of active volcanoes with the following major subjects:

1. Geological study on the active volcanoes with field survey, age determination and chemical analysis to make geological maps and related documents of volcanoes.
2. Study of magma generation, differentiation, ascent and eruption processes based on geological, petrological, geophysical and geochemical observations.
3. Assessment of volcanic activity with ground deformation, thermal or volcanic gas monitoring and the urgent observation at volcanic eruptions.

Miyakejima volcano is continuing intensive volcanic gas emission since August 2000. The volcanic gas emission rate is gradually decreasing, but the emission rate is still high as more than 10 kt of SO₂/day. Because the acid gases sometimes reach the residential area, the island residents of 4,000 people are still evacuated from the island, in spite of the decreasing risk for further major eruptions. A task force team of GSJ/AIST is conducting the study of the Miyakejima volcanic activity including 1) SO₂ emission rate monitoring with COSPEC, 2) plume gas composition monitoring, 3) groundwater monitoring, 4) visual observation from a helicopter and 5) analyses of volcanic ashes. Temporal increases of earthquake and deformation activities were observed at Hakone volcano in July 2001. GSJ/AIST conducted the immediate observation of ground deformation monitoring and volcanic gas observation. Continuous studies on volcanic gas, ground deformation and seismic activity are ongoing on the vigorously steaming Satsuma-Iwojima Island to model the degassing process of convective rhyolitic magma. The geological map of Kirishima volcano was published in 2001 as the 11th publication of the series "Geological map of Volcanoes".

Groundwater Monitoring

GSJ/AIST has a network composed of 40 groundwater observation stations in and around the Tokai and Kansai areas, which is one of the most well-equipped groundwater observation networks for earthquake prediction in the world. In 2001, based on an inferred pre-slip model of the impending Tokai

Earthquake, we estimated the preseismic changes in groundwater levels at Haibara and Kusanagi wells, which are two of the most sensitive wells to earthquakes in our observation network. It will help to make a more accurate detection of preseismic groundwater level changes related to the impending Tokai earthquake. In May 2002, we detected the preseismic groundwater level changes associated with earthquake swarms off the east coast of the Izu Peninsula, Japan. These changes are quantitatively explained by preseismic crustal strain changes caused by a magmatic dike intrusion which is a possible source of the earthquake swarms.

As the slow crustal movement, which is considered to be caused by an aseismic slow slip on the plate boundary in and around the Tokai region, has continued since March 2001, the occurrence of next large earthquake is now being feared. The groundwater observation network of GSJ together with other observation networks now has higher expectations to detect the precursory phenomena of the next Tokai Earthquake.

Earthquake

There were major earthquakes with a magnitude equal to or over than M6.0 from January 2001 to the end of July 2002 in and around Japan as follows.

-Akinada "2001 Geiyo earthquake"

M6.7 on March 24, 2001 (at a depth of about 50 km)

-Southern Iwate Prefecture

M6.4 on Dec. 2, 2001 (depth of approximately 120 km)

-Ocean area near Yonagunijima

M7.3 on Dec. 18, 2001 (depth of approximately 10km)

-Ocean area south of Ishigakijima

M6.6 on Mar. 26, 2002 (depth of approximately 10 km)

-Near Taiwan

M7.0 on Mar. 31, 2002

Among them, the "Geiyo earthquake" of March 24, 2001, is the most hazardous earthquake in this period, which occurred in the western Japan, registering a maximum seismic intensity of 6 lower (JMA scale), with 2 deaths, 287 injuries and 48,602 damaged houses (Fire and Disaster Management Agency, 2001).

Japanese earthquake researches are organized by the Headquarters for Earthquake Research Promotion, a special governmental organization attached to the Prime Minister's office (now belongs to the Ministry of Education, Culture, Sports, Science and Technology), which was established in accordance with the Special Measure Law on Earthquake Disaster Prevention. Major research organizations under this Headquarters are Geological Survey of Japan (GSJ), Japan Meteorological Agency (JMA), Geographical Survey Institute (GSI), National Research Institute for Earthscience and Disaster Prevention (NIED) and universities. GSJ plays an important role mainly in the following earthquake research fields. Recent activities are briefly introduced below.

Active fault studies

Active Fault Research Center (AFRC) was launched in April 2001 as one of the major research units

of the new Geological Survey of Japan (GSJ) in association with the establishment of the National Institute of Advanced Industrial Science and Technology (AIST). AFRC is one of the responsible organizations for active fault studies in Japan under the Headquarters for Earthquake Research Promotion of the Japanese government (HQERP). AFRC is making efforts to provide innovative and reliable scientific results to help reduce losses from future earthquakes and tsunamis.

AFRC published the first Annual Report on Active Fault and Paleoearthquake Researches in October 2001 to present recent research results. The geological studies are reported on 12 active faults among the 98 major active faults that have been selected by HQERP for prompt survey. After the occurrence of the Tottori-ken Seibu earthquake (MJ=7.3) on Oct. 6, 2000, we conducted urgent studies on the ground ruptures, liquefaction and fault modeling. The preliminary results appear in this report. Geological studies of tsunami deposits in eastern Hokkaido, paleoearthquake studies of some archeological sites and crustal deformation in the Boso Peninsula are also included in this report. The surface fault survey and trenching studies of the 1999 Turkish earthquake along the western segments of the North Anatolian fault, a trenching study of the Chelungpu fault in Taiwan which was activated during the 1999 earthquake, and the paleoearthquake study in western Washington state, USA, are reported as international cooperation with the General Directorate of Mineral Research and Exploration of Turkey, the Taiwan Central Geological Survey and the United States Geological Survey, respectively.

The second edition of the Kyoto Neotectonic Map on a scale of 1:500,000 and explanatory text were published in March 2002. In this product, a seismotectonic map, gravity tectonic map and paleoearthquake data map were recently included.

Earthquake seismology

As the evaluation for the next large earthquake is basically based on a statistical method, the estimated time is about an order of 100 years. To improve this situation, new research projects based on new hypotheses on the mechanism of the earthquake process are necessary. GSJ/AIST are conducting earthquake researches to clarify the structure and dynamic processes of the deeper parts of active faults and predict the strong motions in the plain regions as follows:

- (1) Comprehensive joint research on the modeling of the slip process of earthquake source faults and plastic flow below the seismogenic region
- (2) Studies on the deep structure of active faults
- (3) Studies on the deep subsurface structure of the plains for strong motion estimation

The northern part of the Itoigawa-Shizuoka tectonic line and Nagamachi-Rifu fault are selected as model fields for the comprehensive joint research project. The research project is consisted of closely integrated researches of field observations, laboratory experiments and modeling. Aseismic slip on the deeper parts of the faults will be detected by dense GPS arrays. For the 4th year of this project, the reflection/refraction survey at the northern part of the Itoigawa-Shizuoka tectonic line will be performed. The deep fault materials in the Hatagawa and Hidaka areas have been studied to find the relationship between brittle and ductile deformation. We also perform high temperature, high pressure rock deformation experiments. All the results will be incorporated to make models on the deep slip process at seismogenic inland faults.

Deep structures of active faults are also studied for the Nojima fault in the 1995 Kobe earthquake region,

2000 western Tottori earthquake fault and Atotsugawa fault system. These studies indicate that a notable fault zone structure generally exists for major active faults.

Rock Mechanics

GSI has conducted rock fracture experiments as a basic study on the earthquake generation mechanism. As large earthquakes usually occur at great depths with a long time interval, the experimental approach is therefore important for understanding the process that takes place in and around the earthquake source region.

We developed a high-speed 32-channel acoustic emission (AE) waveform recording system, which enables us to monitor the detailed time-space distribution of AE activity during the preparation and rupture process of rock samples. We studied the catastrophic fracture processes of intact or jointed rock samples under triaxial compression mainly focusing on the 1) modeling of the nonlinear and hierarchical rupture/fracture behaviors and physics of non-homogeneous fault and 2) mechanism of precursory anomalies such as clustering and change of seismic b-value and the mechanism of natural disasters related with rock failure such as earthquake and rock burst.

The fault formation process in a uniform granite sample under triaxial compression was investigated in detail. By keeping the increasing rate of circumferential strain constant, we succeeded to control the brittle fracture process quasi-statically and retrieve the samples loaded up to various stages of fault formation. After the peak stress, two stages of quasi-static stress drop with different rates were identified before the dynamic failure. First, a number of linear cracks occur on the sample surface then a shear fracture nucleates locally near the mid-plane of the sample surface. The fracture plane grows toward the sample interior as well as along the sample surface. The critical size of the fracture plane was 30 to 50 mm along the surface and 5 to 7 mm in depth.

The geometry effect on rupture propagation was studied using large rock samples with a bent fault. Multiple unstable sliding was observed, in which the first sub-event stopped at the bend, while the following sub-event propagated over the entire fault plane. The time interval between these two sub-events is inversely correlated to the displacement of the first sub-event. This can be explained by a numerical simulation based on a rate- and state-dependent friction law. We also found that the frictional strength begins to recover at 10^{-4} to 10^{-3} seconds after a slip had stopped then increases in proportion with the logarithm of the duration of stationary contact.

Geological Hazards Map

“ Eastern Asia Geological Hazards Map” was published by the Geological Survey of Japan (GSJ), AIST in May, 2002.

This map is one of the results produced by the Eastern Asia Natural Hazards Mapping Project (EANHMP) that was proposed and promoted by the GSJ since 1994 and contributed to the International Decade for Natural Disaster Reduction (IDNDR). The EANHMP was implemented by each national committee in East and Southeast countries and supported by international organizations, especially CCOP.

This map is consisted of two sheets, namely one is to show mainly the geologic hazards of endodynamic origin such as seismic hazard including Tsunami and volcanic hazard. The other sheet shows geologic

hazards of exodynamic origins partly induced by human activities such as landslide, coastal erosion/deposition etc. with background geology. A sheet showing the legend and an explanatory pamphlet in English (49p.) are attached. The map scale was determined to be 1:7,700,000 because of sheet size.

20 copies were sent to each member country (organization). This map can be purchased at the following dealer. (price:¥3,500)

Geoscience Information Services Co., Ltd.

2-32-6, Umezono, Tsukuba, Ibaraki, 305-0045 Japan

Fax. +81-298-56-0568 E-mail: gsis@kb3.so-net.ne.jp

1.3. Environmental Geology

Nuclear Waste Disposal

Methods of disposing of high-level radioactive waste have been studied by international organizations and many countries around the world. There is the international consensus that, among all methods, geological disposal is the most scientifically and practically feasible with the least problems. The basic policy of the Japanese Government on the disposal of high-level radioactive waste is to solidify it in a stable form (vitrified waste), followed by storage for cooling it for 30 –50 years and disposal in geological formations at deeper than 300 meters underground.

In June 2000, the Specified Radioactive Waste Final Disposal Act was enacted to ensure the systematic and reliable disposal of high-level radioactive waste. The selection of the disposal site is made through a process of three steps: 1) selection of preliminary investigation areas, 2) selection of detailed investigation areas and 3) selection of a site for construction of final disposal facilities. At each step, the items of investigation and assessment are clearly stipulated by the Act.

Research and development on high-level radioactive waste disposal has been carried out in several research institutes in the public and private sectors. GSJ/AIST, Japan Atomic Energy Research Institute (JAERI), Japan Nuclear Cycle Development Institute (JNC) and Central Research Institute of Electric Power Industry (CRIEPI) are engaged in research and development aimed at improving the reliability of geological disposal technology and developing advanced methods on safety assessment. The Nuclear Waste Management Organization of Japan (NUMO) is developing technology for the improved economy and efficiency of the disposal operation.

GSJ/AIST studies assessment methods for uncertainties in geo-environmental data and models. These methods will develop geo-environmental site models and long-term behavior scenarios for safety assessment. They also investigate groundwater behavior along saltwater-fresh water interface and tectonic stress variation with depth. Results of these studies will be important for assessing and designing possible sites.

Soil Contamination

The Environmental Quality Standards for Soil were issued in 1991 and Guidelines for Investigation

and Countermeasures for Soil and Groundwater Pollution were established in November 1994 to protect human health from toxic substance such as heavy metals (Cd, Pb, Cr^{IV}, Hg, As and Se), VOC's, PCBs and dioxins. However soil contamination in urbanized areas is still a severe and urgent environmental issue in Japan. For example, based on the data from local governments, the Ministry of Environment (MOE) reported on 31 March 1999 that total number of contaminated sites in urbanized areas was over 1,500.

Under these social conditions, MOE made a law to protect soils from contamination on 29 May 2002. The law places industrial land owners who use toxic substances under an obligation to survey their lands when they quit their business. The law requires the polluters to clean up the polluted soil when soil contamination is recognized. The law also urges the Japanese government to make a national fund program for the remediation of contaminated lands when the cause of pollution is not clear and local governments cannot identify the party responsible for the remediation. GSJ/AIST, besides many private companies of geological consulting, mining, civil engineering, etc., has been involved in these problems and conducted research and development.

To ensure the smooth implementation of surveys and countermeasures, it is very important to clarify the natural levels of toxic heavy metals of soils in urbanized areas. GSJ/AIST started the 1:50,000 geochemical mapping project for toxic heavy metals at the Anegasaki area, Chiba prefecture. The XRF chemical analysis and metal leaching test based on the Environmental Quality Standards and US EPA method 3050B were carried out on 300 soil samples from this area. The prototype of a 1:50,000 geochemical map will be published by March 2003. A three-year interdisciplinary program among five research units in AIST was started this summer to develop assessment and remediation technologies of soil contamination.

ANNUAL COUNTRY REPORT

Member Country: JAPAN

Period: 2002

GEO-INFORMATION SECTOR – Geodata and Information Management Programme

1 . GEODATA AND INFORMATION MANAGEMENT PROGRAMME

Summary

- Governmental new “GIS Action Program 2002 – 2005” adopted geological important projects for digitization of geoscience maps, standardization and international cooperation on constructing geological metadata and “Geoinformation Network for East and Southeast Asia”.
- The geological standard describing geological maps was first established as JIS A0204: Geological map– symbols, colors, patterns, terms, and presentation of legend on July 20, 2002.
- “International Workshop for CCOP Metadata” was successfully held in Tsukuba, Japan on 20-21 February 2002 organized by GSJ and CCOP. Subsequent discussions on the metadata are expected to make common specifications for the metadata in the region.
- Newly reformed GSJ (personnel, about 330) still meets with serious problems on administration, finance and evaluation in the framework of hypertrophic (Comment: I think strong is good enough. Hypertrophic usually refers a build up of your muscles.) new AIST. Geoinformation Division (personnel, 23) is responsible for geoinformation management, the public relations and coordination of the GSJ.
- On demand publication services of geological map printing was initiated in 2001.
- Geoscience databases have been accumulated in the AIST RIO-DB system that is available through <http://www.aist.go.jp/RIODB/riohomee.html>. Construction of the geoscience DB in RIIO-DB is being accelerated this year by AIST financing support because of its usefulness to the public.

Annual Review of Technical Programs / Activities

Overview

A new strategy for the National Special Data Infrastructure (NSDI) using Geographic Information System (GIS) was released on 20th February 2002. It was “the GIS Action Program 2002 – 2005” decided by “the Liaison Committee among Ministries and Agencies on GIS”. The purpose is to provide the nation for a better life through IT services using GIS. The action program includes the construction of a geodata

infrastructure such as geological standardization, digitization of geological maps, compilation of digital geological hazards maps with the related data and the promotion of international cooperation on constructing geological metadata and a “Geoinformation Network for East and Southeast Asia”. These tasks are to be carried out mainly by the GSJ/AIST.

The GSJ has contributed to the construction of a geodata infrastructure in cooperation with many domestic governmental organizations on the administrative framework and their missions. The following organizations are closely connected with the GSJ on each geodata.

- Geographic data: Geographic Survey Institute (GSI), Ministry of Land, Infrastructure and Transport (MLIT)
- Coastal oceanographic data: Hydrographic and Oceanographic Department, Japan Coast Guard
- Energy and mineral resources:
New Energy and Industrial Technology Development Organization (NEDO),
Japan National Oil Corporation (JNOC), and
Metal Mining Agency of Japan (MMAJ)
- Seismological data: Governmental Headquarters for Earthquake Research Promotion (combining many institutes)
- Remote sensing data: Earth Remote Sensing Data Analysis Center (ERSDAC)
- Nuclear waste disposal: Japan Nuclear Cycle Development Institute (JNC)

The GSJ starts discussions with local governments, private sectors and universities on the mutual utilization of geodata in the field of urban geology.

As explained at the last meeting, the GSJ is now a generic name for five geoscientific research units, Geoinformation Division, International Geoscience Cooperation Office, Geological Museum, two Collaborative Research Teams of Hokkaido and Kansai. A Research Coordinator for public relations coordinates the GSJ. Geoinformation Division is responsible for geoinformation management, the public relations and coordination of the GSJ, supporting the Research Coordinator. We still meet with serious problems on management, evaluation, finance etc. in the framework of a strong new AIST. In these circumstances, the GSJ is remaking a new strategy to become “the efficient national geodata center for the public”.

Two topics are worthy of special mention: one is the establishment of geological standards as JIS (Japanese Industrial Standard) and the other is GSJ’s active contribution to the international cooperation for geoinformation through “International Symposium on Geoinformation via Internet” and “International Workshop for CCOP Metadata” held in Tsukuba, Japan on 18-21 February 2002. The details of topics are described in next section.

Activities

a) Geological standards

As only the GSJ has been publishing national geological maps of Japan, it has been considered that GSJ’s geological maps give Japanese geological standards describing geologic time, rock type and geological elements. However, there have been no standards approved formally for the public. The

geological standards describing geological maps were firstly established as JIS A0204: Geological map—symbols, colors, patterns, terms and presentation of legend on July 20, 2002. The JIS establishment is also the first success of the new AIST. The standard is a modification of ISO 710: Graphical Symbols for use on detailed maps, plans and geological cross-sections and newly added presentation of legend. The GSJ will distribute the English version overseas and try to make an agreement on international standards in cooperation with foreign countries.

The standardization of bibliographic metadata and geological map catalogue is necessary for East Asian countries to communicate with each other through the Internet. The GSJ is promoting 'CCOP Metadata' strategy for defining common items of metadata. Common specifications for the metadata are expected to reach an agreement in this fiscal year by CCOP Member Countries.

The XML is a useful tool to transfer geological spatial data through the Internet. Recently, G-XML, which is a Japanese protocol for encoding spatial data through extensions, was built upon XML. The JIS X 7199 based on G-XML Version 2 was set up on August 25, 2001. Presently, the current specification is Version 2.5. The work plan to converge G-XML with the OpenGIS Consortium's (OGC) GML specification is on-going. The outline is introduced, for example, at <http://gisclh.dpc.or.jp/gxml/contents-e/>. The GSJ and some related companies are examining the possibility of applying G-XML to geological maps.

b) Dissemination of geological maps and databases by the GSJ

Geological and thematic maps

Geological base maps with scales of 1 : 50,000 and 1 : 200,000 have been published on 7 sheets and 1 sheet, respectively in 2001. The coverage over the land becomes 890/1274 sheets (70%) with scale of 1: 50,000 and 100/124 sheets (80.6%) with scale of 1:200,000. In addition to them, eight thematic maps and four digital geoscience maps (CD-ROM) were also published in 2001. On demand publication services of geological map printing was initiated in 2001 if there is no way to obtain available maps in stock.

New digital geoscientific CD-ROMs in 2001 and 2002

- Urban Geoscientific Data of East and Southeast Asia – GIS data sets of 11 cities – by CCOP and GSJ, 2001
- Urban Geoscientific Data of East and Southeast Asia – GIS data sets of 11 cities – by CCOP and GSJ,, 2nd Edition, 2001
- GEOLIS - CD-ROM (1985-1999) by GSJ, 2001
- Index Database to the Geological Maps of Japan (1960-1999) by GSJ, 2001 (in Japanese)
- Database of the Marine Seismic Profiles around Japan by GSJ, 2001
- Geological Guide of Hokkaido by GSJ, 2001
- Geological Maps of Japan 1:200,000 (Images) Ver.2.0 by GSJ, 2002
- Geological Map of Fuji Volcano (CD-ROM Version) by GSJ, 2002
- Geothermal Resources Map of Tohoku and Kyushu (CD-ROM Version) by GSJ, 2002
- Geoscientific Maps of Southern Part of Korea, Western Part of Japan and Their Adjoining Seas 1:4,000,000 (CD-ROM Version) by GSJ, 2002

RIO-DB: Research Information Databases

The AIST databases are available in RIO-DB through the Internet at:

<http://www.aist.go.jp/RIODB/riohomee.html>. The construction of geoscience DBs was accelerated this year by AIST financing support because of its usefulness to the public. The contents are continually revised. The main databases from the GSJ are Geological Literature Search System (GEOLIS), World Geological Map Search System (G-MAPI), Geological Map Database, Geochemical Standards Database and Rock Property Database. Geophysical Exploration Activity Database (EXACTS) was a new project in 2001. In the above, GEOLIS is a big database of more than 230,000 registered literatures. The access through the Internet reached more than 245,000 hits in 2001.

c) Collaboration with CCOP

The GSJ is taking a new direction in the field of geoinformation with CCOP this year. “International Symposium on Geoinformation via Internet” and “International Workshop for CCOP Metadata” were successfully held in Tsukuba, Japan on 18-21 February 2002 organized by GSJ and CCOP. The meetings were attended by participants from the CCOP Member Countries; Cambodia, China, Indonesia, Japan, Korea, Malaysia, Papua New Guinea, Philippines, Thailand and Vietnam. Also present were the representatives from Mongolia, BRGM, BGS, CIFEG, ESCAP, TNO-NITG and UNESCO. The workshop recommended the establishment of a Task Force under CCOP to facilitate the urgent task of the development of CCOP Regional Metadata, which contains metadata for bibliographic data, geological maps and geoscience databases. Japan was elected the chairman of the task force.

1.3. Proposed Future Activities and Assistance Required from CCOP in Support of Future Activities

Suggestions

“CCOP Metadata” is still one of the urgent projects in the CCOP region. The metadata of various geoscientific maps and databases accumulated at each organization will give the region a useful guide for settling many common geological problems in the region. Common specifications for the metadata make it easy to use. The GSJ recommends continuing discussions on CCOP Metadata after the Tsukuba meeting, 2002. We would like to assist and support CCOP on this matter.

The standardization for geological maps is the subsequent target in the region. We believe that the geological standards describing geological maps: JIS A0204: “Geological map– symbols, colors, patterns, terms and presentation of legend” are accepted more than ISO 710. The GSJ plans to distribute the English version to the region for more discussions and progress.