





# Institute for Geo-Resources and Environment Ten Big News Items 2009





**Ten Big News Items from the Institute for Geo-Resources and Environment** 

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Our research focuses on three major areas central to ensuring the sustainable development of society: (1) utilization of the geosphere to establish a sustainable and stable energy cycle, (2) protection of the geosphere for the safety and health of the nation, and (3) procurement of a stable supply of natural resources for industrial activities and society at large. Ten Big News Items for 2009 were selected from projects carried out at our institute over the past year that have the most potential to contribute to the achievement of sustainable development, based on the following factors:

- Noteworthy research results
- Launch, continued implementation, or completion of an important project or joint research
- Contribution to society through the publication of research results or through technology transfer
- Creation of an important knowledge base or basic research results
- Events, awards, etc. that bring honor to the Institute
- Important initiatives taken by the Institute that lead to advances in its research

I sincerely hope that this brochure will help you in understanding the activities and contributions of our institute.

March 2010

Dr. Yusaku Yano, Director, Institute for Geo-Resources and Environment National Institute of Advanced Industrial Science and Technology

## Ten Big News Items 2009

Title	Resarch Group - Researcher	
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International contribution to establish risk management in mineral resource development and environmental pollution control	S. Murao, J. Hara, Y. Kawabe, T. Komai Geo-environment Risk RG	Photo B
Contributing to society through assessment of Japan's nationwide geothermal resources	Geothermal Resources RG	Photo C
Developing advanced techniques for assessing coastal seawater/freshwater interfaces and fault structure	Groundwater RG; Exploration Geophysics RG	Photo D
Upgrade of Water Environment Map: publication of No. 6 the Yamagata Basin	I. Machida Groundwater RG	Photo E
Joint research conducted under a cooperation agreement on research into the safety of geological disposal of radioactive waste	Integrated Geology RG; Experimental Geoscience RG	
AIST-CGS-JOGMEC joint research achievements	Y. Watanabe, T. Moriyama, T. Nishimura, T. Takagi Mineral Resources RG	
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Compilation and publication of CD-ROM version of Fuel Resource Geology Map "Eastern Nankai Trough"	S. Goto, S. Morita, M. Tanahashi, O. Matsubayashi Fuel Resource Geology RG	Photo G
New developments in the research on CO <sub>2</sub> geological storage	CO <sub>2</sub> Geological Storage RG, etc.	





Photo B



Photo G



Photo F



Photo C



Photo D



Photo E

## Ten Big News Items 2009 Release and promotion of Geo-Environmental Risk Assessment System (GERAS-3: Detailed Model)

Y. Sakamoto, Y. Kawabe, J. Nishiwaki, J. Hara, T. Komai Geo-environment Risk RG

#### [Outline]

We are contributing to reducing environmental pollution risks and soil remediation costs through the development and release of Geo-Environmental Risk Assessment System (GERAS-3: Detailed model) to assess the environment problem such as soil and groundwater contamination.

#### (Details)

Within our medium-term plan to develop Geo-Environmental Risk Assessment System, we have developed the detailed model that is able to simulate the transport phenomena of contaminated substances from the soil layer to the aquifer, and can quantify the change in human risk with time and space by contamination of multiple components. Under this research project, the system for assessing the health risks by soil and groundwater contamination for all regulated substances has been developed to contribute to risk management such as decontamination and remediation and released through a press announcement on September 30, 2009. Where development of analytical methods is concerned, we developed and proposed a new flow analysis technique for multi-phase, multi-component system that enables the quantification of individual health risks by modeling the transport phenomena from the soil layer to the aquifer.

#### [Applications of research results]

We anticipate that Geo-Environmental Risk Assessment System (GERAS-3: Detailed Model) will be utilized in applications such as those listed below as a result of being made publicly available.

Used by 300 companies to date

- Detailed assessment of contaminated sites for businesses and factories
- (2) Quantitative assessment of contamination countermeasures, and risk and cost reduction
- (3) Application of risk assessment methods to bioremediation technology etc.
- (4) Application with respect to legal and social systems.

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#### Ten Big News Items 2009

## International contribution to establish risk management in mineral resource development and environmental pollution control

S. Murao, J. Hara, Y. Kawabe, T. Komai Geo-environment Risk RG

#### [Outline]

We investigated the present situation of artisanal/small-scale mining which poses environmental and social risks within the sites and to the surrounding community, and sought to address the issue through environmental governance and technology. We also developed and disseminated eco-friendly soil remediation that makes use of both plants and microorganisms as technology for reducing environmental risks in the Asian region.

#### (Details)

We reviewed global trends in artisanal/small-scale mining and identified key factors such as "responsible mining to the society" and "acceptable mining by the society". We presented our findings at the Regional Implementation Meeting ahead of the 18th Session of the United National Commission on Suptainable Development (CSD 18) and United Nations Commission on Sustainable Development (CSD-18) and at an environmental geology symposium. For the contribution, we were given an excellence award from the Japanese Society of Geo-Pollution Science, Medical Geology and Urban Geology.

In the area of reducing environmental pollution risks, we worked with private enterprises and universities to develop phytoremediation technology that employs both plants and microorganisms, and enabled its application to an oil-contaminated site in Thailand. This research and its verification received a special incentive award from the Engineering Advancement Association of Japan (ENAA).

#### [Applications of research results]

Towards a solution of the environmental risk issues, based on natural and social sciences, we will apply our findings to design regional participatory programs, to nurture human resources and to develop

environmental governance in local communities. We will also seek to reduce the cost of soil remediation by promoting new environmental remediation technologies both in Japan and overseas.

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Senior Research Scientist Satoshi Murao on his presentation at the UN Conference Center in Bangkok

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A schematic illustration of soil and groundwater contamination due to multi-component mineral oil, and a sample analysis result (concentration

distribution in an aquifer, and risk assessment

An example of environmental degradation by artisanal/small-scale mining



Phytoremediation technology verification experiment (at an oil-contaminated site in Thailand)



result)

#### Ten Big News Items 2009

## Contributing to society through assessment of Japan's nationwide geothermal resources

#### [Outline]

Assessing Japan's nationwide geothermal resources is a major project of the Geothermal Resources Research Group's 2nd medium-term plan, and we have announced progress at successive academic conferences since 2008. Our findings have begun to be broadly used by central and local governments and covered by mass media from around 2009.

#### [Details]

This is the first GIS-based assessment of geothermal resources conducted in Japan. We have presented our findings at the 2008 annual meetings of the Japan Geoscience Union and the Geothermal Research Society of Japan and elsewhere. For the survey, we are systematically assessing resources according to the ideal power generation method for different temperatures by using a 1 km grid GIS-based volumetric method. We have assessed hydrothermal power generation for resources with temperatures above 150 °C and of 53–120 °C, and by the end of fiscal 2009, we will have added the 120-150°C range.

#### (Applications of research results)

Our survey results are an important component of the interim report of the Agency for Natural Resources and Energy's Geothermal Power Research Group (released June 9, 2009). Our assessment also featured prominently in a June 27, 2009 broadcast of Science Zero (an NHK TV series), and results were incorporated into the Ministry of the Environment's survey from November 2009 of the potential of geothermal power as a renewable energy source. More recently, inquiries from prefectural governments are increasing. The above are among the ways that the results of our research are becoming public knowledge and contributing to future geothermal resource development plans.



Distribution of 53–120°C hydrothermal resources (assuming Kalina cycle power generation). The color scale indicates power generation per km<sup>2</sup>.

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#### Ten Big News Items 2009

#### Developing advanced techniques for assessing coastal seawater/freshwater interfaces and fault structure Groundwater RG; Exploration Geophysics RG

#### (Outline)

We conducted research on the evaluation of the deep zone geology and hydrological environment of coastal regions as part of research on the development of basic technologies for geological storage commissioned by the Agency for Natural Resources and Energy, Japan. We have a research with observation wells through an interface of seawater/freshwater, and have conducted integrated geophysical surveys including a shallow sea area. We have found several new understandings about hydro-geological environment in deep zone.

#### (Details)

We have applied some new concept borehole tests in Horonobe, Hokkaido, to forecast changes in groundwater flow caused by longterm changes in the global environment and to identify safe and stable areas of groundwater. We are seeking to develop new techniques for ascertaining stable areas of groundwater by making use of the differences in absorption of groundwater observed in geological samples collected from deep strata. We are also working on the development of geophysical exploration techniques for coastal zones. We are developing a seafloor electromagnetic instrument for shallow water zones and techniques for combined interpretation of land and sea data including electromagnetic and seismic reflection surveys.

#### [Applications of research results]

The survey and analysis techniques, databases and other outcomes of this trial will be used to assess the geological stability and environment of candidate locations for waste disposal. The knowledge gained from this research can also contribute to research on  $CO_2$  geological storage and geothermal resource utilization.



Drilling in midwinter at Horonobe



A seafloor electromagnetic instrument currently being developed

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**Geothermal Resources RG** 

#### Ten Big News Items 2009

## Upgrade of Water Environment Map: publication of No. 6 the Yamagata Basin

#### [Outline]

Water Environment Maps were upgraded to meet the changing social needs.

#### [Details]

Water Environment Maps are one of the thematic maps that contain hydrogeological information in basin scale. These maps were edited by the Groundwater Research Group. In order to improve upon the maps, guidelines were formulated based on information from other hydrogeological maps, interviews from specialists, and group discussions. From these guidelines, the Water Environment Maps were upgraded.

The No.6 the Yamagata Basin contains about 100 sets of data such as geology, topography, hydrogeology, water tables, water quality distributions, isotope distributions and subsurface temperature distributions. These are organized in a way that enable the user to compare and examine different sets of data on the same map.

Isao Machida, Narimitsu Ito, Youhei Uchida, Reo Ikawa, Atsunao Marui, Yusaku Taguchi (2010): Edit Guideline for Water Environmental Map-To provide the user's expecting information- *Bull. Geol. Surv. Japan*, vol.61 (1/2), p. 75-83.

#### [Applications of research results]

These maps can be used for regional groundwater and geothermal studies. We plan to work with universities and other research institutes to make similar maps for the whole nation. The maps may also be made available online.



A map display of Water Environmental Map, showing Fe concentrations in shallow and deep groundwater.

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#### Ten Big News Items 2009

## Joint research conducted under a cooperation agreement on research into the safety of geological disposal of radioactive waste

Integrated Geology RG; Experimental Geoscience RG

#### [Outline]

Under a 3-party joint research agreement between AIST, the Japan Atomic Energy Agency (JAEA) and the Japan Nuclear Energy Safety Organization (JNES), Experimental Geoscience Research Group Senior Researcher Yasuo Tomishima was dispatched to the JAEA Nuclear Safety Research Center to conduct research on a performance assessment code for geological disposal of high level radioactive waste. We also conducted joint research with JNES and with JAEA's Mizunami Underground Research Laboratory and Horonobe Underground Research Center on geochemical investigation and groundwater flow model validation methods.

#### [Details]

In the joint research with JAEA Mizunami Underground Research Laboratory, we established methods for surveying and assessing geochemistry and underground microorganisms. In addition to such methods of geo-environmental baseline assessment and methods to assess natural barrier performance, as a means for investigation and assessment that is more closely related to safety assessment, we systemized methods for the validation of groundwater flow models built for safety assessment and we enhanced the actual safety assessment code.

#### [Applications of research results]

The results of this research will be used as indicators for judging safety and quality in reviews of the results of site investigations by implementer. The performance assessment code also provides indices that are useful for identifying targets of research that should be addressed by research facilities supporting regulation moving forward.



Outline of the performance assessment code for geological disposal



Research at JAEA Mizunami Underground Research Laboratory

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## AIST–CGS–JOGMEC joint research achievements

#### Y. Watanabe, T. Moriyama, T. Nishimura, T. Takagi Mineral Resources RG

#### [Outline]

AIST, the Council for Geoscience of South Africa (CGS), and the Japan Oil, Gas and Metals National Corporation (JOGMEC) conducted joint research over the space of 3 years (2007–2009) to assess the potential of South Africa's rare earth resources, and made the findings detailed below.

#### [Details]

The three parties involved in this joint research investigated stratified manganese deposits, carbonatite-alkaline deposits, granite weathering crust that is rich in rare earth elements, placer deposits and other formations in South Africa for rare earth content, amount of rare earth reserves, and the forms in which they exist. We investigated close to 20 locations, and discovered a number of formations that show excellent potential as sources of rare earth elements, including the Palabora apatite deposits and Vergenoeg fluorite deposits (both alkaline rocks), and the Zandkopsdrift carbonatite deposits. The Ministry of Economy, Trade and Industry and private industry was informed of these results through JOGMEC, and some parties are moving ahead with the development process. We also developed ties with South African researchers through our five field surveys in South Africa and two visits to Japan by invited South African researchers. The results of this research were presented at a workshop held at CGS in March 2010, and CGS plans to publish whatever results it can by the end of FY2010.

#### [Applications of research results]

Japan is currently dependent on China for supplying over 90% of its rare earth needs, and needs to establish other supply sources to ensure stable supply. The results of this research will be used as basic data for JOGMEC and Japanese companies to secure interests in South African mines.

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#### Ten Big News Items 2009

## Latest results from research on fuel resources

#### T. Nakajima Fuel Resource Geology RG; H. Yoshioka, S. Sakata Geomicrobiology RG

#### [Outline]

We investigated seabed sediments on the slopes of the continental shelf that look most likely to contain fuel resources, and discovered (1) outer-bank bars, a new intra-channel architectural element, and (2) relation between distributions of methane hydrate (MH) and subseafloor microorganisms.

#### (Details)

(1) Our analysis of 3D seismic data from the Amazon Fan off the coast of Brazil revealed for the first time outer-bank bars, which are intra-channel architectural elements unique to deep seas, and that rise gradually on the outer banks of curves in sinuous submarine channels.

Nakajima et al. (2009) Outer-Bank Bars: a new intra-channel architectural element within sinuous submarine slope channels. Journal of Sedimentary Research, 79, 872–886. Joint researchers: Jeff Peakall, William D. McCaffrey, Douglas A. Paton (Leeds University, UK), Philip J.P. Thompson (Aberdeen University, UK)

(2) As the result of Integrated Ocean Drilling Program (IODP) Expedition 311 at the Cascadia Margin, we revealed the distributions of methanogens and their activity mainly producing methane through carbonate reduction pathway in the MH-bearing sediments.

Yoshioka et al. (2010) Activities and distribution of methanogenic and methaneoxidizing microbes in marine sediments from the Cascadia Margin, Geobiology, 8, 223-233. Joint researchers: Akihiko Maruyama (Institute for Biological Resources and Functions), D.H. Bartlett (Scripps Institution of Oceanograpy)

#### [Applications of research results]

Oil, natural gas, and MH are distributed under the oceanic continental shelves, and our 2 findings will be used to prospect for new oil and natural gas deposits and to pinpoint hydrate-bearing sediments and assess the amount of MH they contain.



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Joint field research of the Spitzkop Complex



Joint field research at Vergenoeg Mine



South African researchers on a visit to Kushikino Mine in Kyushu

#### Ten Big News Items 2009 Compilation and publication of CD-ROM version of Fuel Resource Geology Map "Eastern Nankai Trough" S. Goto, S. Morita, M. Tanahshi, O. Matsubayashi Fuel Resource Geology RG

#### [Outline]

We have compiled a series of fuel resource-related geological data for the Eastern Nankai Trough, covering the offshore Tokai to Kumano-Nada areas, and published a CD-ROM version of Fuel Resource Geology Map "Eastern Nankai Trough".

#### (Details)

The Eastern Nankai Trough has been shown to bear a large amount of sub-seafloor methane hydrates (MH) by geophysical exploration as well as by drilling campaigns. The purpose of this research is to compile the basic data for assessment of potential MH resource in the Eastern Nankai Trough by integrating all the information composed of marine geology maps, existing data on subsurface structure, geomagnetic and gravity anomalies, heat flow, drilling results and results of temperature structure modeling, and to make a publication of geological maps on a scale of 1:500,000 (main map) and 1:1,000,000 (supplementary maps).



Fuel Resource Geology Map "Eastern Nankai Trough"

CO<sub>2</sub> Geological Storage RG, etc.

Shusaku Goto, Sumito Morita, Manabu Tanahashi, Osamu Matsubayashi, Ko-ichi Nakamura, Masao Komazawa, Takemi Ishihara, Masato Joshima, Masao Hayashi, Nobutaka Oikawa, Toshiaki Kobayashi, Takao Inamori, Tatsuo Saeki (2010): Fuel Resource Geology Map "Eastern Nankai Trough", Digital Geoscience Map FR-2, Geological Survey of Japan, AIST.

#### [Applications of research results]

National program to develop the MH as a new energy resource for the Eastern Nankai Trough area is now underway by the government. We anticipate that the new Fuel Resource Geology Map will be utilized as the important data for resource assessment of the MH in this area and for its development.

Joint researchers: Ko-ichi Nakamura, Masao Komazawa, Takemi Ishihara, Masato Joshima (Institute of Geology and Geoinformation, AIST), Masao Hayashi, Nobutaka Oikawa, Toshiaki Kobayashi, Tatsuo Saeki (Japan Oil, Gas and Metals National Corporation), Takao Inamori (Japan Oil, Gas and Metals National Corporation (JOGMEC), currently JGI, Inc.)

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#### Ten Big News Items 2009

## New developments in the research on CO<sub>2</sub> geological storage

#### (Outline)

The Ministry of Economy, Trade and Industry is carrying out a largescale demonstration project aimed at implementing CO<sub>2</sub> geological storage. To provide technical support, we have embarked on the 2nd phase of CO2 geological storage research aimed at creating a versatile, general-purpose technical foundation.

#### [Details]

We have launched research in the following areas commissioned by the Research Institute of Innovative Technology for the Earth (RITE) under a Ministry of Economy, Trade and Industry grant: • Enhancement of the precision of simulation models for predicting

- long-term behavior
- Development of combined monitoring methods
- Development of methods of assessing CO2 movement in interbedded sandstone and mudstone formations

We will also apply a geophysical postprocessor (AIST registered software: H22PRO-1081) for the STAR general-purpose reservoir simulator, which was originally developed for geothermal research, to predict  $CO_2$  behavior. We have also endeavored to publish research outcomes, for example with the publication of geochemical research results up to 2008 in a special issue of a journal published by the Japan Association of Mineralogical Sciences. In December 2009, we promoted technical exchanges with the Korea Institute of Geoscience and Mineral Resources (KIGAM) by participating in the 2nd joint workshop held in Gyeongju, Korea. We are also intensifying our research cooperation with American counterparts, and as part of such cooperation, sent



2nd joint workshop with KIGAM

one researcher to the Los Alamos National Laboratory, and two to the Lawrence Berkeley National Laboratory on a medium-to long-term basis.

#### (Applications of research results)

Implementing geological storage requires the development of efficient monitoring technology and assessment of the safety of stored CO<sub>2</sub>. Providing basic technology and information that contributes to such ends is also important. Contact: Shinsuke NAKAO, e-mail: sh-nakao@aist.go.jp, phone: +81-29-861-3955



## Ten Big News Items from the Institute for Geo-Resources and Environment



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### **Research Groups**

- Geothermal Resources Research Group
- Fuel Resource Geology Research Group
- Mineral Resources Research Group
- Exploration Geophysics Research Group
- Geo-analysis Research Group
- CO2 Geological Storage Research Group
- Integrated Geology Research Group
- Experimental Geoscience Research Group
- Geo-Environmental Systems Research Group
- Resource Geochemistry Research Group
- Geomicrobiology Research Group
- Groundwater Research Group
- Geo-environment Risk Research Group

Researches at the Institute for Geo-Resources and Environment are carried out at two locations: Tsukuba Central 7 and Tsukuba West.

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