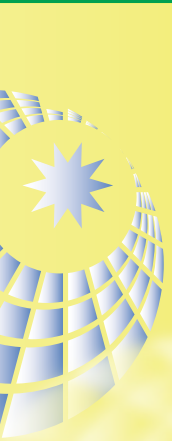


# Ten Big News Items



**AIST**  
**Institute for Geo-Resources and Environment**  
**Ten Big News Items 2011**



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

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 2011 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

The 11 March 2011 Off the Pacific Coast of Tohoku earthquake brought about the catastrophic damage to Japan. Many people lost their lives by the tsunami came after the earthquake. The nuclear power plant accident brought about long term anxiety and sufferings. Our institute was forced to stop experiments for several months owing to damages to facilities and deficit of electricity supply. In this situation, however, we started survey and analysis of groundwater, soil, or faults at Fukushima and Tohoku area, just after the earthquake. Also, we started planning of Geo-risk survey project which will contribute to prepare for coming earthquake hazards. We started actions to increase renewable energy supply including geothermal energy and geothermal heat pump systems, corresponding to shortage of energy supply. This Ten Big News Items 2011 consists of news items relating to the earthquake disaster, and other important news items.

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

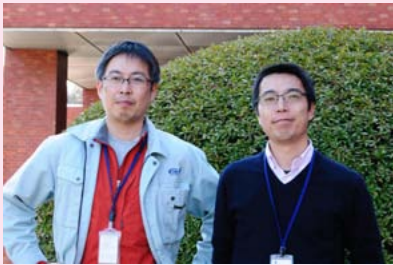
March 2012

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

## Ten Big News Items 2011

Title	Research Group, Researcheres	Photo
● <b>Earthquake disaster-related news</b>		
Urgent research and groundwater modeling for the recovery from the Tohoku earthquake	Y. Uchida, N. Ito, M. Koshigai, N. Kohara, R. Ikawa, M. Yoshioka, I. Machida, A. Marui (Groundwater R.G.)	A
Risk assessment of toxic chemicals in tsunami sediments from the Tohoku earthquake	Y. Kawabe, J. Hara, T. Yasutaka, Y. Sakamoto, M. Zhang (Geo-Environmental Risk R.G.); T. Komai (Deputy Director)	B
Radioactive contaminants in soils: behavior, countermeasures, and risk assessment	T. Yasutaka, Y. Kawabe, M. Zhang (Geo-Environmental Risk R.G.); T. Komai (Deputy Director)	C
Geophysical research for mitigation of geological hazards caused by earthquakes	T. Uchida, T. Ueda, M. Jinguuji, Y. Nakashima, T. Yokota (Exploration Geophysics R.G.); S. Okuma (Geology and Geoinformation R.I.)	D
Response to increasing demand for geothermal energy and ground-coupled heat pump systems after the Tohoku earthquake	Geothermal Resources R.G.; Groundwater R.G.	E
Recovery of research activity after the Tohoku earthquake	All members of GREEN	F
● Fluid circulation from submarine landslides in a high methane flux sedimentary basin	S. Morita, T. Nakajima (Fuel Resource Geology R.G.)	G
● Discovery of anaerobic methane oxidizing archaea in terrestrial subsurface environments	M. Takeuchi, H. Yoshioka, Y. Seo, D. Mayumi, S. Sakata (Geomicrobiology R.G.)	H
● Installation of analytical and beneficiation facilities for critical metal ores	T. Takagi, T. Ohno, K. Sanematsu, M. Hoshino, Y. Kon, K. Shin, T. Otake, Y. Horiuchi, M. Tsunematsu (Mineral Resources R.G.); Y. Watanabe (Prime Senior Researcher)	I
● Technical development of bentonite exploration methods	S. Takakura (Geo-Environmental Systems R.G.); T. Takagi (Mineral Resources R.G.)	J
● Development of a new system using a functional mineral material as CO <sub>2</sub> -adsorbent and its application to agricultural use	M. Suzuki, K. Nagayoshi, E. Sakayori (Resource Geochemistry R.G.); K. Tsukimura	K
● Contribution to establishing guidelines for recycling and disposal of cathode-ray tube glass	H. Sugita, Y. Imoto (Geo-analysis R.G.); Y. Sakamoto, Y. Kawabe (Geo-Environmental Risk R.G.); T. Komai (Deputy Director)	L
● Evaluation of soil thermal properties for geothermal heat pump systems	M. Jinguuji (Exploration Geophysics R.G.)	M
● Promotion of research on safety evaluation of CO <sub>2</sub> geological storage	CO <sub>2</sub> Geological Storage R.G., etc.	None
● Studies on fluid-driven rock fracturing	X. Lei (CO <sub>2</sub> Geological Storage R.G.)	N

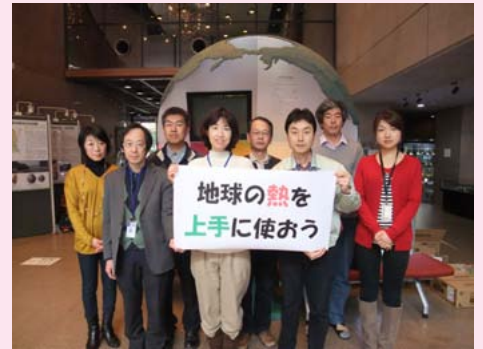




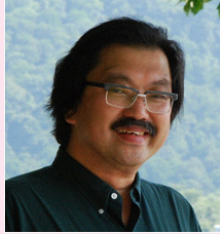
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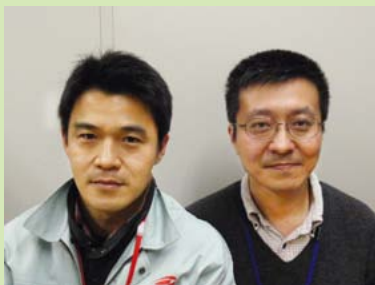
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A



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K



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M



N

# Urgent research and groundwater modeling for the recovery from the Tohoku earthquake

Y. Uchida, N. Ito, M. Koshigai, N. Kohara, R. Ikawa, M. Yoshioka, I. Machida, A. Marui (Groundwater R.G.)

## 【Outline】

Just after the giant Tohoku earthquake, we prepared a simulation of groundwater flow for the coastal plain of the Tohoku district. We have begun an evaluation of the risk to groundwater from saline and nuclear pollution. We are also evaluating the potential for energy production using the heat in groundwater.

## 【Details】

- Simulation of groundwater flow: A simulation was prepared using published databases related to groundwater and a three-dimensional geological database from the Geological Survey of Japan. Its results were compared with data obtained after the earthquake to evaluate the risks of groundwater pollution by tsunami inundation and nuclear contamination. Results were widely used to obtain potable water, for example, and also received widespread coverage in newspapers and mass media.

- Renewable energy: Geothermal heat in shallow groundwater is under consideration as an energy-producing measure. We have begun a study of groundwater flow rates and thermal exchange rates.

- Nuclear waste study: We have gained new knowledge about the stability of deep groundwater in the coastal area of Tohoku.

## 【Application of research results】

- Provision of potable water after the earthquake
- Evaluation of risks to groundwater
- Use of groundwater for renewable energy
- Groundwater information for the national nuclear waste program
- Release of hydro-environmental map



Drilling at Otsuchi-town, Iwate.

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# Risk assessment of toxic chemicals in tsunami sediments from the Tohoku earthquake

Y. Kawabe, J. Hara, T. Yasutaka, Y. Sakamoto, M. Zhang (Geo-Environmental Risk R.G.); T. Komai (Deputy Director)

## 【Outline】

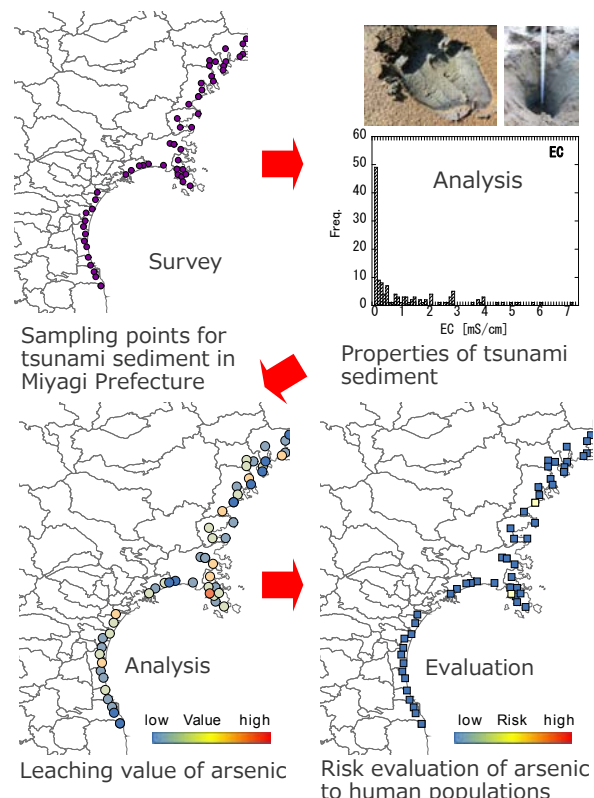
We evaluated the risk levels from toxic chemicals in the tsunami sediments deposited after the Tohoku earthquake using our risk assessment model GERAS.

## 【Details】

Our group collected more than 200 tsunami sediment samples after the Tohoku earthquake to obtain a set of properties for risk evaluation. Heavy metal contents of the tsunami sediment were almost the same as those in nearby soil or sea sediment. Although there were some sites exceeding the Japanese environmental standard for leaching concentrations of arsenic and lead, the risk levels of these elements to humans were almost entirely low.

## 【Application of research results】

Developing strategies for risk mitigation and risk reduction.



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# Radioactive contaminants in soils: behavior, countermeasures, and risk assessment

T. Yasutaka, Y. Kawabe, M. Zhang (Geo-Environmental Risk R.G.);  
T. Komai (Deputy Director)

## 【Outline】

In collaboration with local governments, research institutes, and private companies, we have studied the status and behavior of radioactive contaminants in soils, risk assessment for taking pertinent countermeasures, and effective decontamination techniques to support the recovery from the Tohoku earthquake.

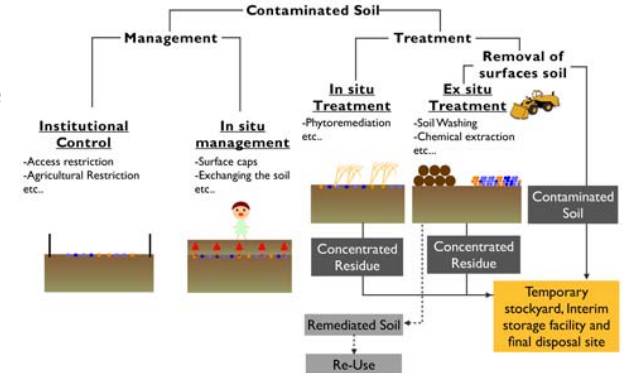
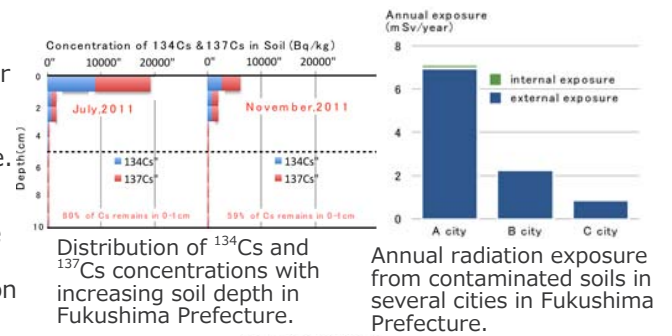
## 【Details】

We made predictions of the long-term behavior of radioactive contaminants based on their distribution and changes in concentration in soils of Fukushima Prefecture. In this connection we developed a simplified approach for in situ analysis of concentration of radioactive contaminants. We then performed radiological risk assessments of contaminated soils to human health. Finally, we proposed potential countermeasures for reducing waste volume and risks considering cost, time, release of contaminants, and other factors.

## 【Application of research results】

Providing reference information for decontamination and decision making.

Evaluating the distribution and migration of radioactive contaminants within soils, risk assessment, and long-term prediction.



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# Geophysical research for mitigation of geological hazards caused by earthquakes

T. Uchida, T. Ueda, M. Jinguuji, Y. Nakashima, T. Yokota (Exploration Geophysics R.G.);  
S. Okuma (Geology and Geoinformation R.I.)

## 【Outline】

We have begun studies on geophysical exploration techniques to help in mitigation and reduction of geological hazards caused by great earthquakes.

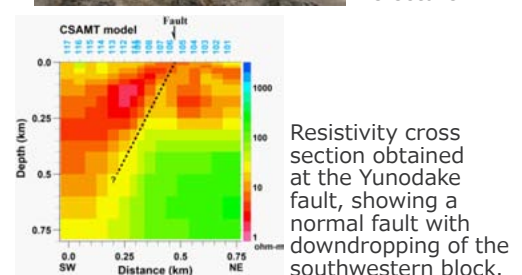
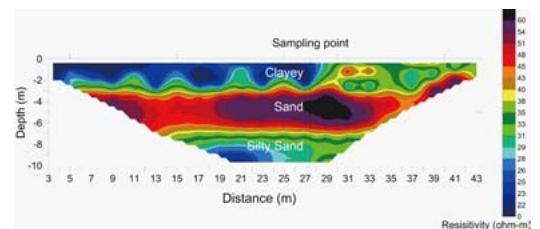
## 【Details】

Three topics will be studied:

- Cone penetration tests and surface geophysical measurements will be conducted over soil liquefaction sites along the Tone River to investigate shallow underground structures and physical properties related to liquefaction risk.
- Airborne electromagnetic and surface electrical surveys will be carried out over tsunami-affected lands in Miyagi and Fukushima Prefectures to map zones of salt-water invasion, particularly in agricultural areas.
- Electromagnetic exploration methods will be used to delineate resistivity structures around the active faults that caused numerous aftershocks in Fukushima Prefecture.

## 【Application of research results】

Restoration from earthquake hazards and risk mitigation in the future.



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# Response to increasing demand for geothermal energy and ground-coupled heat pump systems after the Tohoku earthquake

Geothermal Resources R.G.; Groundwater R.G.

## 【Outline】

Damage to the power supply system of Japan by the Tohoku earthquake has triggered intense interest in renewable energy, including geothermal technologies such as geothermal power generation and ground-coupled heat pump systems. Our researchers are responding to this rise in public attention.

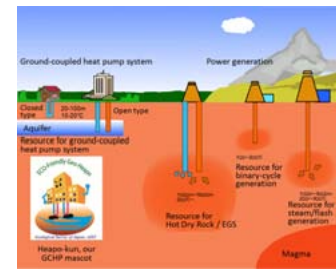
## 【Details】

Geothermal heat can be utilized over a wide temperature range. Geothermal power generation is more stable than other renewable energy sources such as solar and wind. Ground-coupled heat pump systems are recognized as an effective energy-saving technology. We are conducting the following studies of high-temperature geothermal resources: monitoring and evaluation techniques to achieve the economic coexistence of hot springs and geothermal power generation, developing binary-cycle generation systems using hot springs, and compiling a database of geothermal resources. In the field of shallow underground thermal energy, we are acquiring and accumulating subsurface information and studying evaluation techniques and potential mapping for ground-coupled heat pump systems. In addition, we have participated in many interviews for the mass media and delivered invited lectures on geothermal energy the earthquake. In November 2011, we hosted the Ninth Asian Geothermal Symposium in Ibusuki to exchange information with researchers in other Asian countries, where remarkable progress in geothermal development is being made.

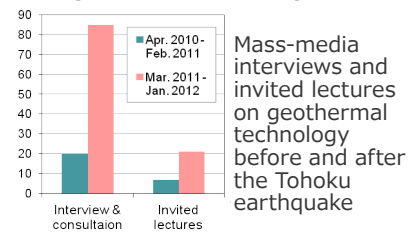
## 【Application of research results】

Promotion of geothermal power, the use of locally produced energy, and greater use of ground-coupled heat pump systems in Japan.

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The wide range of geothermal technologies



Mass-media interviews and invited lectures on geothermal technology before and after the Tohoku earthquake



The Ninth Asian Geothermal Symposium

# Recovery of research activity after the Tohoku earthquake

All members of GREEN

## 【Outline】

The Institute for Geo-Resources and Environment (GREEN) is in Ibaraki Prefecture just south of Fukushima. The Tohoku earthquake caused severe damage to our facilities, and our experimental work was forced to stop for several months. During the postseismic period, we undertook surveys and analyses of groundwater movement, soil conditions, and faults to contribute to the recovery of the Tohoku area. The National Institute of Advanced Industrial Science and Technology (AIST) adjusted its budget and started reconstruction of GREEN's research facilities, which we had decided to consolidate at one location in Tsukuba. Working through the summer with limited air conditioning and power, we promoted the Geo-Risk project to survey and analyze the geological and environmental risks associated with the tsunami and the ensuing nuclear power plant failures. We also participated in planning of the construction of a new AIST branch in Fukushima for research on renewable energy technologies, including geothermal energy and geothermal heat pump systems. At the same time, we continued our major research projects on geo-resources and geo-environments. We reported on these activities at our annual GREEN symposium on the theme "The earthquake disaster and geo-system," held in December 2011.

GREEN has been striving to restore our research conditions as we proceed with our research activities aimed at helping our country recover from the earthquake disaster.



Green Report 2011



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# Fluid circulation from submarine landslides in a high methane flux sedimentary basin

S. Morita, T. Nakajima (Fuel Resource Geology R.G.)

## 【Outline】

Detailed seismic analysis in the Ministry of Economy, Trade, and Industry (METI) survey “Sanriku-oki 3D” has revealed that submarine landslide deposits control natural gas circulation in the sedimentary beds of the Sanriku-oki Basin off Shimokita Peninsula.

## 【Details】

Detailed seismic analysis shows that submarine landslides are predominantly deposited in Pliocene and younger formations in the Sanriku-oki Basin. The landslides show typical deformation consisting of repetitive folds and thrusts and have characteristic dewatering structures. Their acoustic anomalies indicating the presence of a gas phase suggest that they play an important role in controlling natural gas circulation. Conversely, a high flux of natural gas contributes to submarine ground instability and affects the development of sedimentary basins.

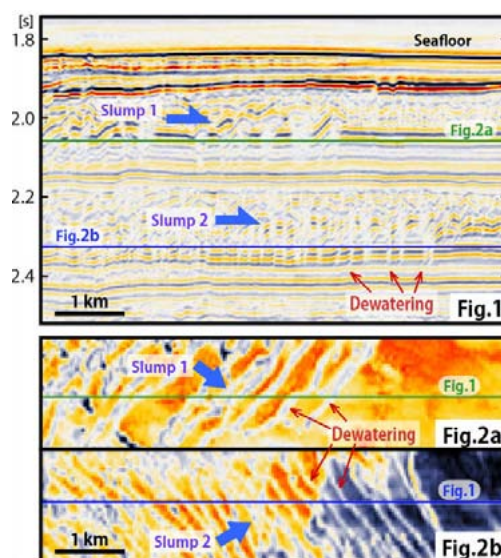
- Morita et al. (2011) Submarine Mass Movements and Their Consequences, *Advances in Natural and Technological Hazards Research*, 31, Springer, 311-320.
- Morita et al. (2011) *Journal of the Geological Society of Japan*, 117, 95-98.

## 【Application of research results】

New insight into circulation systems of formation fluids for evaluation of hydrocarbon potential.

- Collaborators: Nakanishi, S., Okitsu, O. and Hanamura, Y. (JX Nippon Oil and Gas Exploration)

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Seismic images of submarine landslide (slump) deposits in Sanriku-oki Basin showing relation of slumps and dewatering structures in vertical profiles (Fig.1) and time slices (Fig.2).

# Discovery of anaerobic methane oxidizing archaea in terrestrial subsurface environments

M. Takeuchi, H. Yoshioka, Y. Seo, D. Mayumi, S. Sakata (Geomicrobiology R.G.)

## 【Outline】

We have documented anaerobic oxidation of methane mediated by a newly recognized subgroup of anoxic methane oxidizing archaea (ANME) in terrestrial subsurface sediments.

## 【Details】

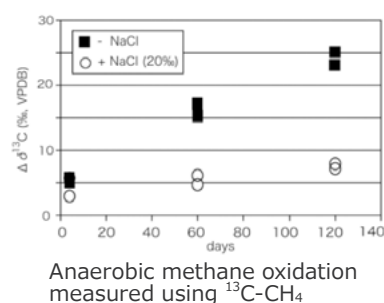
The Holocene sediment of the Kanto Plain was drilled and subjected to molecular analysis and metabolic activity measurement based on stable isotopes. The 16S rRNA sequence analysis clearly revealed the presence of a distinct subgroup of ANME-1, designated ANME-1a-FW. The potential activity of anaerobic methane oxidation was detected and was greater in low-salinity conditions, indicating that ANME-1a-FW is adapted to freshwater. This is the first finding of anaerobic methane oxidation in the terrestrial subsurface containing freshwater.

- Takeuchi et al. (2011) *Environmental Microbiology*, 13 (12), 3206-3218.

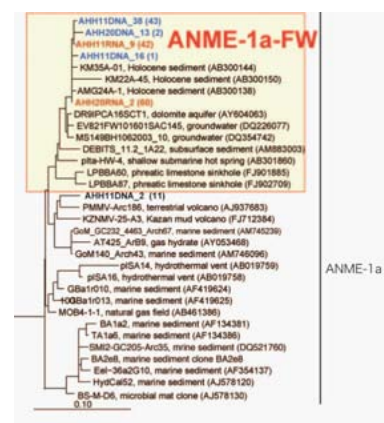
## 【Application of research results】

Possible repression of methane emissions into the atmosphere.

Resource development and environmental conservation.



Anaerobic methane oxidation measured using  $^{13}C$ -CH<sub>4</sub>



Phylogenetic position of the ANME-1a-FW archaeal taxa

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# Installation of analytical and beneficiation facilities for critical metal ores

T. Takagi, T. Ohno, K. Sanematsu, M. Hoshino, Y. Kon, K. Shin, T. Otake, Y. Horiuchi, M. Tsunematsu (Mineral Resources R.G.); Y. Watanabe (Prime Senior Researcher)

## 【Outline】

We have installed new analytical and beneficiation facilities for critical metal ores at AIST for accurate and rapid evaluation of mineral deposits.

## 【Details】

Japan is faced with a serious shortage of critical metals such as rare earths due to export controls by China, and alternative sources of the metals should be found as soon as possible. To help meet this challenge, we have installed the following analytical equipment: Field-emission electron probe micro-analyzer (FE-EPMA), mineral liberation analyzer (MLA), X-ray diffractometer (XRD), multi-collector inductively coupled mass spectrometer (MC-ICP-MS), UV-laser galvano system, laser-Raman spectrometer, and bead sampler.

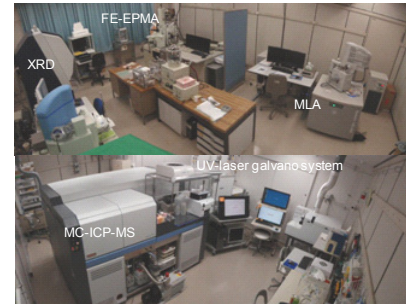
We have also installed beneficiation equipment including magnetic separators, high-tension separator, Wilfley table, rock crushing machines, hydro-cyclone, column-type flotation machine, large centrifuge, and zeta-potential analyzer.

Two large mud traps and a dust collection system have been installed in the beneficiation laboratory to prevent leakage of radioactive materials.

## 【Application of research results】

Securing mineral resources through joint studies with government and private sectors.

Geological studies of mineral deposits, development of beneficiation techniques, and training personnel.



Examples of analytical equipment



Examples of beneficiation equipment

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# Technical development of bentonite exploration methods

S. Takakura (Geo-Environmental Systems R.G.); T. Takagi (Mineral Resources R.G.)

## 【Outline】

Joint research by AIST and Kunimine Industries Co., Ltd found that the geoelectrical method is efficient for bentonite exploration and that electrical resistivity can be used for evaluation of the quality of bentonite.

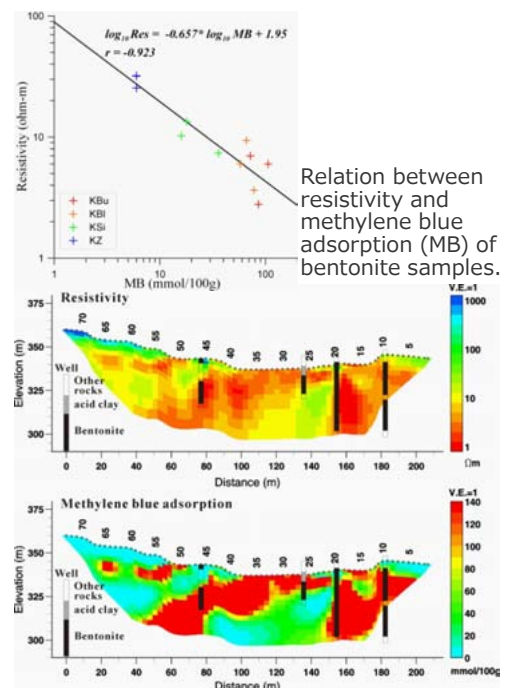
## 【Details】

We analyzed the resistivity structure of a bentonite mine using a DC resistivity survey. We also measured resistivity along with other physical and chemical properties of bentonite samples and found a good correlation between resistivity and methylene blue adsorption, used as a quality indicator for bentonite. This correlation enabled us to estimate the distribution of methylene blue adsorption from the resistivity structure. These estimates were confirmed by boring surveys.

- Takakura et al. (2011) Butsuri-Tansa (Geophys. Explor.), 64, 309-318 (in Japanese).
- Takakura et al. (2011) Butsuri-Tansa (Geophys. Explor.), 64, 359-366 (in Japanese).

## 【Application of research results】

Substitute or complementary survey methods for investigation and evaluation of subsurface bentonite and other clay minerals.



2D resistivity section analyzed from geoelectrical data (top) and distribution of methylene blue adsorption derived from the resistivity section (bottom), with borehole results.

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# Development of a new system using a functional mineral material as CO<sub>2</sub>-adsorbent and its application to agricultural use

M. Suzuki, K. Nagayoshi, E. Sakayori (Resource Geochemistry R.G.); K. Tsukimura

## 【Outline】

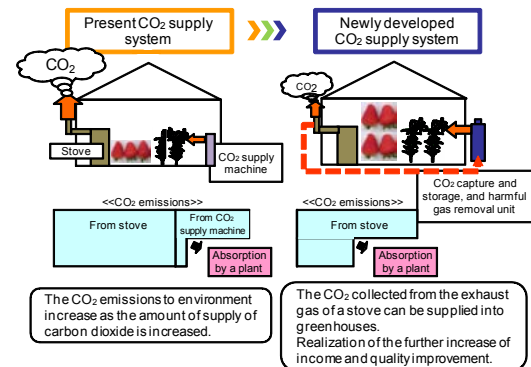
This study aims to develop a new agricultural system and technology that can effectively recover, store, and reuse CO<sub>2</sub> in exhaust gas from heaters in greenhouses to save energy and reduce CO<sub>2</sub> emissions.

## 【Details】

This study was proposed in FY 2010 and approved by Ministry of Agriculture, Forestry and Fisheries as a three-years project. To promote plant growth, greenhouses commonly rely on fossil-fuel stoves for supplementary heat plus a high-CO<sub>2</sub> atmosphere achieved by injection of CO<sub>2</sub> from an outside source. Our design reduces total emissions by capturing CO<sub>2</sub> from the exhaust stream of the stove, using a mineral material as a CO<sub>2</sub> adsorbent, then using the recovered gas for atmospheric CO<sub>2</sub> augmentation. We have constructed a prototype unit and used it in demonstration experiments at various greenhouses. The study is being carried out in collaboration with AIST, Nippon Light Metal Company, Ltd., Nara Prefectural Agricultural Experiment Station, Osaka Gas Co., Ltd, and the National Agriculture and Food Research Organization. We got a prize in "TX Technology Showcase in Tsukuba 2012" for a poster-presentation on the progress of the study.

## 【Application of research results】

- Reduce CO<sub>2</sub> emissions in agricultural activities
- Contribute to quantity and quality of agricultural products



Schematic diagrams of current and proposed greenhouse systems.



Prototype unit for CO<sub>2</sub> recovery and recirculation.

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# Contribution to establishing guidelines for recycling and disposal of cathode-ray tube glass

H. Sugita, Y. Imoto (Geo-analysis R.G.); Y. Sakamoto, Y. Kawabe (Geo-Environmental Risk R.G.); T. Komai (Deputy Director)

## 【Outline】

We have carried out research on cathode-ray tube glass (CRTG) to investigate the leaching and diffusion of heavy metals from the glass in the soil environment.

## 【Details】

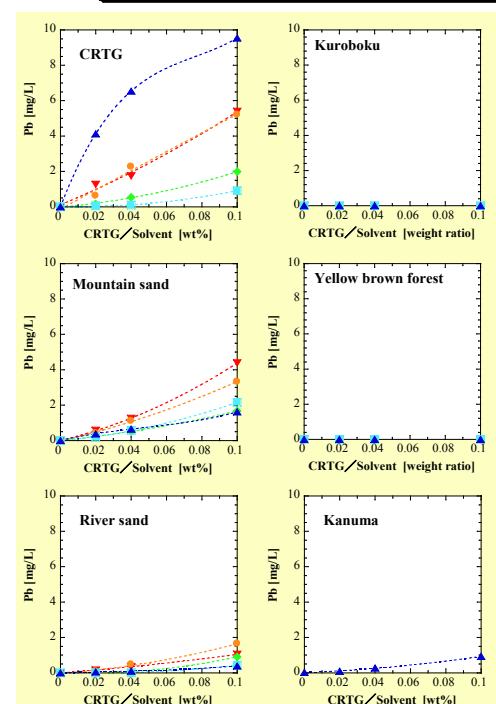
Significant amounts of CRTG will be discarded with the transition to terrestrial digital broadcasting in coming years. However, widespread adoption of thin-screen TVs makes it difficult to recycle and reuse the CRTG exported abroad. Thus landfill disposal will probably become an increasingly important management option. We examined in detail the effects of solvent pH (The solvents were prepared by adding HCl or NaOH solution to ion-exchanged water.) and soil species ("Kuroboku", "Yellow brown forest" and "Kanuma" are popular soils in Japan.) on leaching and diffusion of hazardous elements resulting from landfill disposal of CRTG. We found that specific kinds of soil have the potential to prevent elution of Pb and Sb into the environment by inhibiting leaching or by adsorption.

The fundamental data we obtained were used by the technical review panel to support its policy-making on recycling and disposal of waste CRTG.

## 【Application of research results】

- Improved management of landfill disposal of CRTG

Initial pH ▼ 4.0 ● 6.2 ◆ 8.0 ■ 9.7 ▲ 12.3



Plots of Pb concentration in eluate from CRTG in different soil environments.

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# Evaluation of soil thermal properties for geothermal heat pump systems

M. Jinguuji (Exploration Geophysics R.G.)

## 【Outline】

This study developed a method for in-situ measurement of thermal conductivity and an evaluation method for heat exchangers using the effective thermal conductivity.

## 【Details】

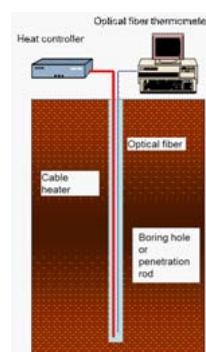
The efficiency of geothermal heat pumps partly depends on thermal properties of the soil, thus heat-pump design requires knowledge of the effective thermal conductivity of soil. This study developed an in-situ logging method using a small-diameter borehole and a penetration rod. A heat-conduction simulation based on a cylindrical model was developed that achieved a good correlation with the result of an actual heat-pump experiment.

- Jinguuji et al. (2010) Journal of The Geothermal Research Society of Japan, 32 (3), 185-191 (in Japanese).

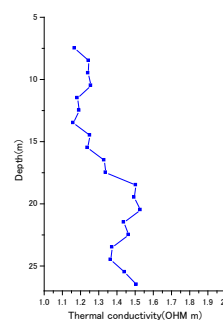
## 【Application of research results】

Use preliminary ground survey results in cost estimates for geothermal heat pump systems

Promote adoption of geothermal heat pumps through faster and simpler design process.

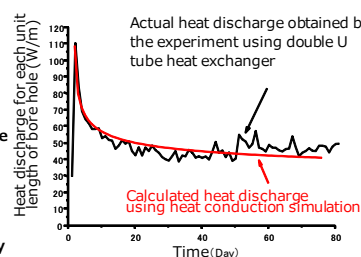
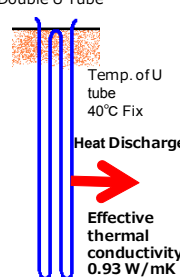


Schematic view of thermal conductivity logging.



Thermal conductivity and resistivity profiles with depth.

Double U Tube



Schematic of cylindrical simulation model (left) and actual experiment using geothermal heat pump (right).

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# Promotion of research on safety evaluation of CO<sub>2</sub> geological storage

CO<sub>2</sub> Geological Storage R.G., etc.

## 【Outline】

We have investigated seismic safety concerns from subsurface CO<sub>2</sub> injection and promoted international technology exchanges related to geological storage of CO<sub>2</sub>.

## 【Details】

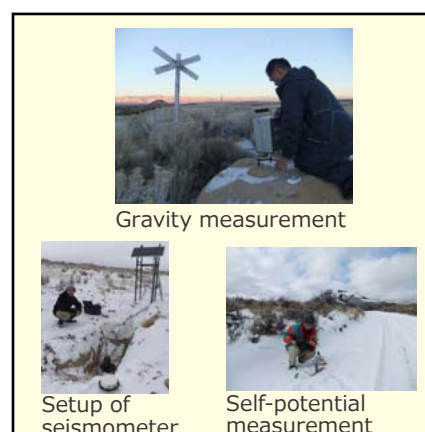
Carbon-dioxide capture and storage in geological formations is a promising technology for mitigating CO<sub>2</sub> emissions to the atmosphere and extending the use of fossil-fuel power plants. To provide technical support for the practical use of CO<sub>2</sub> geological storage, we have promoted joint research on safety evaluation with national research institutes under the U.S. Department of Energy.

We investigated the possibility of induced seismicity from CO<sub>2</sub> injection and the effect of strong motion on reservoir integrity based on research data from the Tomakomai site, Hokkaido, the candidate site for a large-scale demonstration project of CO<sub>2</sub> geological storage. Our results were used to evaluate total reservoir assessments and project planning at the site, contributing to the advancement of the project.

In addition, we have promoted technology exchanges and dissemination of our research and development results. For example, the fourth joint workshop with the Korea Institute of Geosciences and Mineral Resources was held in Daejeon, Korea, in December 2011.

## 【Application of research results】

Development of effective geophysical monitoring technology and assessment of the safety of stored CO<sub>2</sub>.



Monitoring activities at the candidate site for a demonstration project in the USA.



International workshop on CO<sub>2</sub> geological storage.

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# Studies on fluid-driven rock fracturing

X. Lei (CO<sub>2</sub> Geological Storage R.G.)

## 【Outline】

Through approaches ranging in scale from the laboratory to the Earth's crust, we have obtained and published results associated with the role of fluids in the mechanisms of rock deformation and failure..

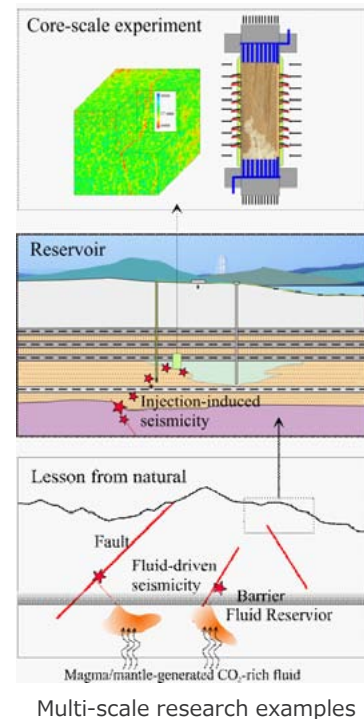
## 【Details】

We have carried out experimental studies of rock deformation and fracturing under well-controlled drainage conditions as well as case studies on fluid-induced and triggered seismicity. Significant results have been published in international journals and presented as invited contributions to international workshops, including the Eighth International Conference on Fluid Dynamics (November 2011, Sendai) and the First KACST-JCCP Joint International Workshop for the Earth's Surface and Subsurface 4D Monitoring (January 2012, Riyadh).

- Lei et al.(2008) Journal of Geophysical Research, 113, 1-12.
- Lei et al.(2009) Physics of the Earth and Planetary Interiors, 176, 224-234.
- Lei (2011) Journal of Asian Earth Sciences, 40, 844-854.
- Lei et al.(2011) Geophysical Research Letters, 38, L24310, doi:10.1029/2011GL049888.

## 【Application of research results】

Technological development and risk assessment related to CO<sub>2</sub> geological storage and enhanced geothermal systems.

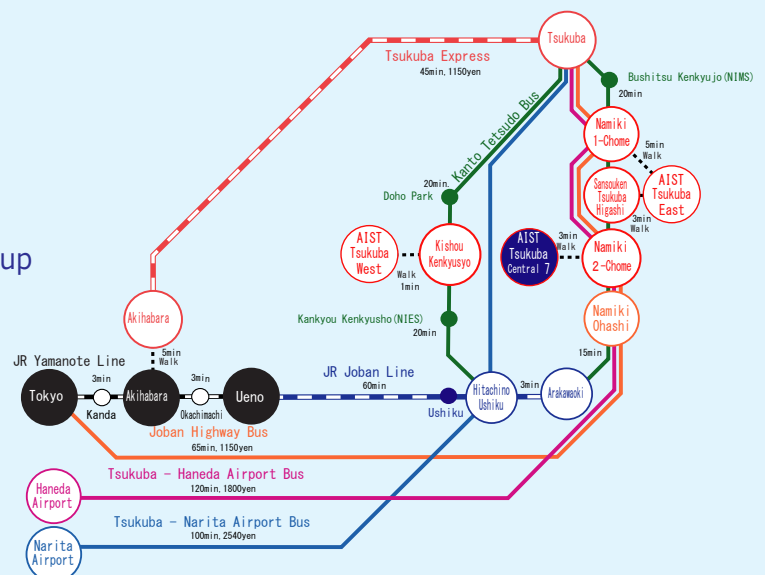


Multi-scale research examples

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## Research Groups

- Groundwater Research Group
- Geothermal Resources Research Group
- Mineral Resources Research Group
- Fuel Resource Geology Research Group
- Geomicrobiology Research Group
- Resource Geochemistry Research Group
- Exploration Geophysics Research Group
- CO<sub>2</sub> Geological Storage Research Group
- Geo-analysis Research Group
- Geo-Environmental Risk Research Group
- Geo-Environmental Systems Research Group



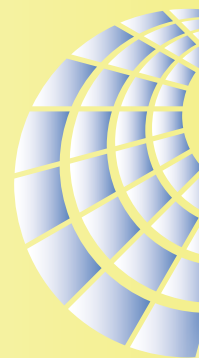


# Ten Big News Items of the Institute for Geo-Resources and Environment



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## Ten Big News Items