AIST NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)
Institute for Geo-Resources and Environment (GREEN)

Ten Big News Items *2008*

from the Institute for Geo-Resources and Environment

Ten Big News Items 2008 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 geo-environment to establish a sustainable and stable energy cycle, (2) protection of the geo-environment for the safety and health of all, and (3) procurement of a stable supply of natural resources for industrial and social activities. This brochure describes ten note worthy projects carried out at our institute over the past year. The items selected for this brochure were chosen because of their

- ●Scientific and technological promise
- ●High standards of technological transfer through collaboration
- ●Initiatives to build the foundation of a geologic knowledge base

I sincerely hope that this brochure will help you understand the nature, activities, and contributions of our institute.

March, 2009

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

Ten Big News Items 2008

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Photo 1


Photo 2


Photo 3


Photo 4


Photo 5


Photo 6


Photo 7


Photo 8

Discovery of wakefieldite-(Nd), a new rare earth mineral

Moriyama,T., Hirano,H., Murakami,H., Watanabe,Y., Mineral Resources RG

【Outline】

Wakefieldite-(Nd), a new rare earth vanadate mineral whose principal component is the rare earth element neodymium, was found in stratified ferruginous manganese ore from the Arise deposit in Kochi Prefecture.

【Details】

The Mineral Resources Research Group has carried out resource assessments of stratified manganese deposits as part of its research to ensure a stable supply of rare earths. Our chemical analysis of stratified manganese ore samples from throughout Japan that are stored in the Geological Museum turned up ferruginous manganese ores that were rich in rare earth elements. Detailed examination of the forms in which these rare earth elements are present led to the discovery in an ore sample from the Arise deposit in Kochi Prefecture of a new mineral with the ideal formula $NdVO_4$. In accordance with rare earth mineral naming protocols, this new mineral was named wakefieldite-(Nd) after wakefieldite-(Y) (YVO_4), a previously reported mineral of the same group. This is the first reported discovery of a wakefieldite mineral in Japan.

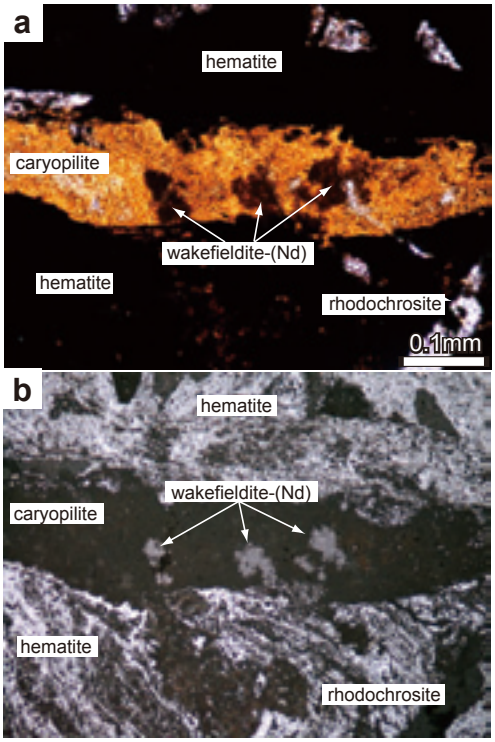
【Applications】

Elucidation of the conditions leading to wakefieldite-(Nd) formation will likely contribute to our understanding of rare earth element enrichment processes and assessment of resources.

【Joint researchers】

Ritsuro Miyawaki, Kazumi Yokoyama, Sou Matusbara (National Museum of Nature and Science)

This research was funded in part by a Sasagawa Scientific Research Grant.



Photomicrographs of wakefieldite-(Nd): (a)Open nicol, (b) refleting light. Grains are several tens microns in diameter and invisible to the naked eye.

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Press releases covering the joint development of a material with excellent CO_2 adsorption and hygroscopic properties

Suzuki,M., Experimental Geoscience RG., Tsukimura,K.

【Outline】

The Experimental Geoscience Research Group announced the development of an amorphous aluminium silicate which shows outstanding CO_2 and water vapor adsorption properties and which can be synthesized industrially on a large scale.

【Details】

The development of technologies for CO_2 removal and energy conservation is vital in this age when global warming and energy issues need to be addressed on a global scale. Based on our knowledge of natural porous materials, we have developed an adsorbent for improving the efficiency of pressure swing adsorption (PSA) CO_2 removal techniques and for desiccant air conditioning that saves energy through employing low temperature waste heat. As a PSA CO_2 adsorbent, the new adsorbent can, at pressures higher than atmospheric pressure, absorb 2.5 times as much CO_2 as zeolites currently in use. As an adsorbent for desiccant air conditioning, it can absorb water vapor over a wide humidity range and can be regenerated at the low temperature of about 70°C.

AIST December 4, 2008 press release: Easily manufactured inorganic porous material with outstanding CO_2 adsorption properties

AIST October 8, 2008 press release: Development of low-cost, high performance inorganic adsorbent/desiccant

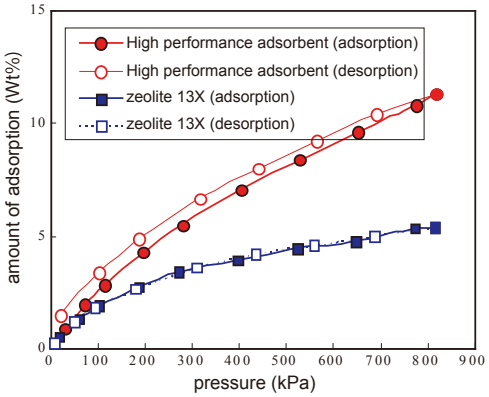
【Applications】

Further research on this material as a PSA CO_2 adsorbent will focus on selective adsorption of mixed gases and optimization of PSA system efficiency for commercial application. In the desiccant air conditioning field, a manufacturer is planning to launch pilot sales of a desiccant rotor in spring 2009.

【Joint researchers】

Masaki Maeda, Keichi Inukai (Materials Research Institute for Sustainable Development, AIST)

The high performance inorganic adsorbent developed by the Experimental Geoscience Research Group



CO_2 adsorption isotherms for the developed adsorbent and zeolite 13X (atmospheric pressure set at zero)

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Ten Big News Items 2008 from the Institute for Geo-Resources and Environment

Mikio Takeda receives American Society of Civil Engineers Journal Award

Integrated Geology RG

【Outline】

"Quantitative Evaluation of the Effects of Hydrogeological Boundary and Initial Conditions on Slug Tests", a paper written by Integrated Geology Research Group researcher Mikio Takeda (together with Ming Zhang and Naoto Takeno) and published in the American Society of Civil Engineers' Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management, was chosen as the journal's Best Theory-Oriented Paper.

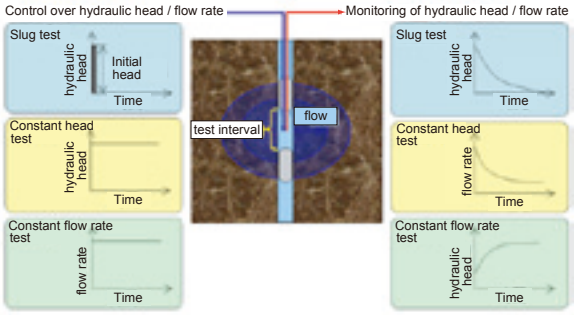
【Details】

The geological disposal of radioactive waste requires the accurate assessment of the coefficient of permeability in rock strata that are less permeable than previously used rock strata. This paper uses numerical and theoretical analyses to quantitatively evaluate the impact of possible discrepancies between model assumptions and actual conditions on the results of slug tests (an aquifer test method that uses in situ boreholes).

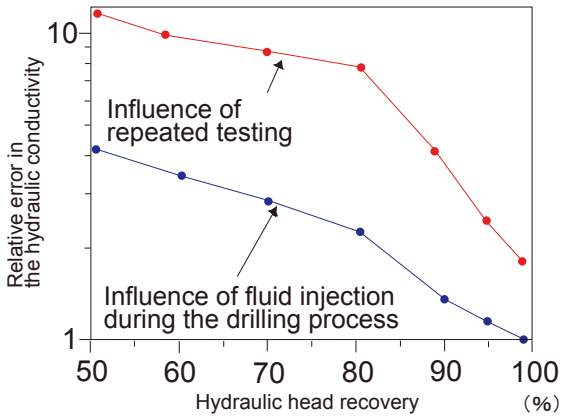
Takeda,et al. (2007) Quantitative Evaluation of the Effects of Hydrogeological Boundary and Initial Conditions on Slug Tests. Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management, vol.11, pp. 48-59.

【Applications】

The results of this research will be used to evaluate data obtained from in situ tests conducted at the siting study stage of projects for the geological disposal of radioactive waste, and will serve as the criteria for evaluating safety assessment review data.



Represeutative single-well permeability tests



Impact of initial hydraulic head discrepancies on evaluating hydraulic conductivity

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Ten Big News Items 2008 from the Institute for Geo-Resources and Environment

Establishment of method to estimate sediment thermal properties

Goto,S., Matsubayashi,O., Fuel Resource Geology RG

【Outline】

The Fuel Resource Geology Research Group has developed a method for simultaneously estimating three thermal properties (thermal conductivity, heat capacity, and thermal diffusivity) of marine sediments.

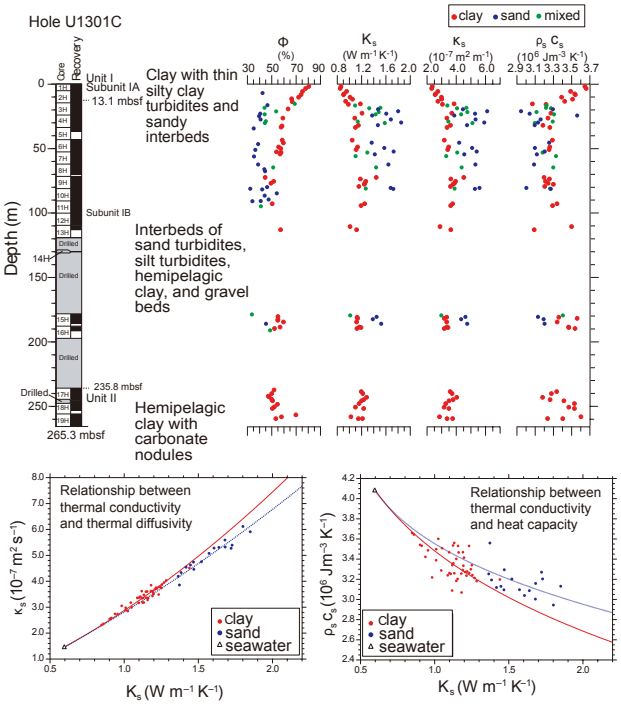
【Details】

The Group has devised a method for estimating the three thermal properties (thermal conductivity, heat capacity, and thermal diffusivity) by inversion analysis of temperature data obtained through the application of the needle probe method that is a standard method of measuring thermal conductivity of sub-bottom sediment. This work is the first successful attempt at simultaneously estimating three thermal properties of sediment from the same sample location. Those thermal property data of sediment core samples collected during the Integrated Ocean Drilling Program (IODP) Expedition 301 in the eastern flank of the Juan de Fuca Ridge were used to formulate the relationships between the thermal properties (thermal conductivity–heat capacity; thermal conductivity–thermal diffusivity). This method can now be applied to the many data of thermal conductivity measurements taken to date for estimating the other thermal properties of sub-botton sediments.

Goto, S. and O. Matsubayashi (2008) Inversion of needle-probe data for sediment thermal properties of the eastern flank of the Juan de Fuca Ridge. J. Geophys. Res., 113, B08105, doi:08110.01029/02007JB005119.

【Applications】

The results of this research are expected to contribute to the modeling of temperature structure that is used in such areas as estimation of oil and natural gas generation, migration and accumulation in sedimentary basir; estimation of methane hydrate formation; and elucidation of the transport of heat and fluids in sedimentary sequences.



(top) Vertical profile of thermal properties at Site U1301 of IODP Expedition 301

(bottom) Relationship between thermal conductivity and thermal diffusivity (left) and between thermal conductivity and heat capacity (right) of sediments (clay and sand sediments)

Φ: Porosity, K_S: Thermal conductivity, κ_S: Thermal diffusivity, $\rho_S c_S$: Thermal capacity (Goto & Matsubayashi, 2008)

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Inter-group joint research achievement: development of a high precision technique for surveying and evaluating soil contaminated with oil

Yokota,T., Mitsuhata,Y., Jinguuji,M.,Nakashima,Y., Ueda,T., Exploration Geophysics RG
Sakamoto,Y., Kawabe,Y., Nishiwaki,J., Takeuchi,M., Komai,T., Geo-analysis RG

【Outline】

To reduce environmental pollution risks and cut survey and remediation costs, the Exploration Geophysics Research Group and the Geo-Analysis Research Group developed a risk assessment technique that combines high precision exploration geophysics survey methods with chemical analysis methods. The new technique is now being used at oil contamination sites.

【Details】

The development of geo-environmental risk assessment techniques is a major goal of the Institute's medium term plan. This research focuses on 3D modeling of the subsurface environment, the development of high precision exploration geophysics and chemical analysis methods for surveying and assessing oil-contaminated soils, and the combination of these methods to develop risk assessment methods. So far, we have developed a new risk assessment technique that enables multiphase flow analysis, and which can be applied to both unsaturated soil layers near the surface and saturated groundwater layers. We have also developed techniques that combine chemical analysis with exploration geophysics techniques using electromagnetic waves and resistivity that can be applied in the field to sites contaminated with mineral oils (petroleum, diesel, fuel oil, etc.).

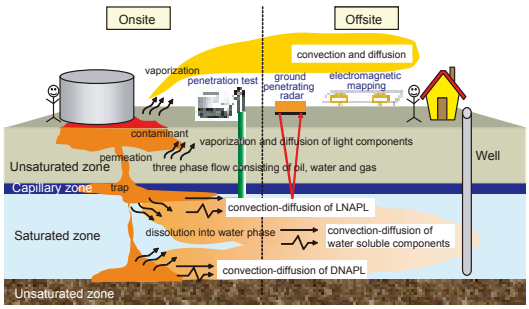
【Applications】

The high precision exploration geophysics technique and geo-environmental risk assessment system will likely be used in such applications as:

(1)Assessment of sites for businesses and factories

(2)Reduction of the cost of surveying and remediating contaminated sites

(3)Application of risk assessment methods to bioremediation technology



Schematic illustration of soil contamination due to mineral oil.
Application of exploration geophysics techniques to assess contamination risks.

Application of exploration geophysics and chemical analysis techniques.
(top left) Use of ground penetrating radar to obtain data. (bottom left) CT scan of a core sample. (top right) Oil film coating a puddle at a site. (bottom right) Oil residues (blackish area) in a core sample.

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Geological and geochemical study on the water-soluble natural gas resource in the Minami-Kanto gas field

Geo-Environmental Systems RG・Fuel Resource Geology RG・Geomicrobiology RG

We launched a 3-year research project in 2008 to elucidate the distribution and quantity of water-soluble natural gas resources in the Kanto Plain and to analyze related geological structures in the area.

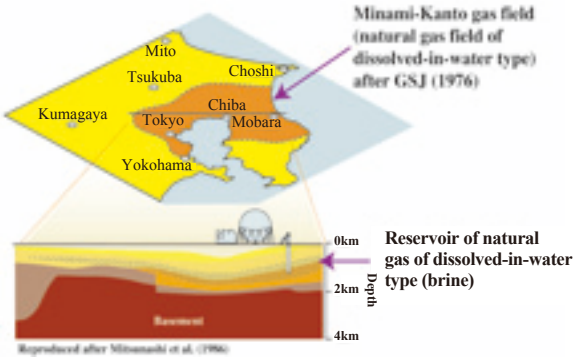
【Details】

The Minami-Kanto gas field holds the largest reserves of water-soluble natural gas in Japan, but the distribution and quantity of the gas reserves have not been accurately estimated for over 30 years. In the same region, a succession of hot spring gas explosions has rekindled public awareness of the need to update geological information regarding such water-soluble gas reserves.

GREEN has joined forces with local governments, developers and other parties to compile and organize existing geological information and hot spring/gas well data, and collect and analyze hot spring water and soluble gas samples. Through this process, we plan to elucidate the distribution and origin of the Minami-Kanto natural gas reserves and the geological structures, and organize and publish our findings as a new fuel resource geological map.

【Applications】

The fruits of this research will not only serve society at large by providing basic data for the efficient use of fuel and hot spring resources in Japan, but will also hopefully contribute to the formulation of guidelines for local government and developers with respect to hot spring drilling in the Kanto Plain from geological and geochemical perspectives. We also envisage that it will be used as basic data for the formulation of policy related to global warming countermeasures and the effective use of currently unused methane gas emissions from hot springs.



CH_4 gas bubbles from a riverbed in the middle area of the Boso Peninsula.

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1st AIST–KIGAM Joint Workshop on CO_2 Geological Storage

CO_2 Geological Storage RG

【Outline】

We held the first AIST–KIGAM (Korean Institute of Geology, Mining and Materials) Joint Workshop on CO_2 Geological Storage. The workshop promoted the exchange of knowledge through presentation of research findings from both countries, and reaffirmed the shared goals and cooperative relationship of the two organizations.

【Details】

The 1st AIST–KIGAM Joint Workshop on CO_2 Geological Storage was held on December 9, 2008 at AIST Tokyo Waterfront. The theme, Basic Studies of Risk Assessment Technology for CO_2 Leakage from Deep Saline Aquifers, attracted 13 presentations.

Commemoration taking a picture in workshop

These included a keynote speech from KIGAM on geological CO_2 storage research in Korea and reports on results and progress being made in research on simulation-based assessment of long-term stability, and monitoring and geo-environmental evaluation methods.

AIST contributed keynote speeches on its research and development program for geological CO_2 storage and basic research on the vital task of assessment of risks of CO_2 leakage from aquifer storage, and contributed reports on results and progress of research on geochemical CO_2 trapping in storage strata, saline environment fluid flow monitoring methods, and application case studies. The workshop prompted lively discussions on the outlook for implementation and application of research, particularly in relation to verification tests, and reaffirmed cooperative ties between our two organizations. It was decided that the 2nd Joint Workshop would be held in Korea in 2009.

【Applications】

The knowledge exchanged at the workshop will be used to promote research on geological CO_2 storage, a key GREEN priority, and will hopefully contribute to the development of effective technologies for the implementation of verification tests. We also anticipate benefits in the form of international cooperation and joint research based on the sharing of knowledge.

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Development of a multi-transmission high-speed resistivity survey system

Motoharu Jinguuji, Exploration Geophysics RG

【Outline】

The Exploration Geophysics Research Group has developed an ultra-high-speed measuring device that enables data measurement at several dozen times the speed of earlier resistivity survey devices, high-density 3D electrical exploration, and real-time resistivity monitoring.

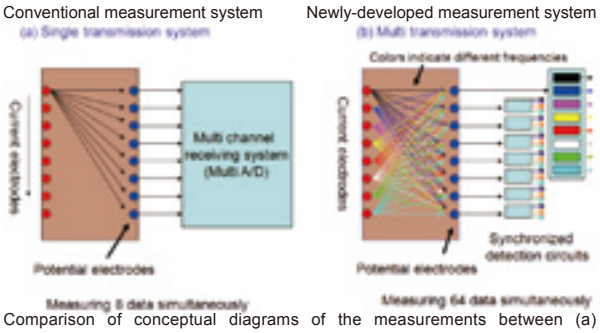
【Details】

Conventional measuring devices measure by using a single frequency current and switching between transmitting and receiving electrodes. The device developed through this research can transmit precisely controlled currents of different frequencies simultaneously from multiple electrodes, and take measurements through synchronous detection with receiving electrodes and separation of signals according to frequency, eliminating the need to switch transmitting electrodes, and enabling dramatically faster data acquisition.

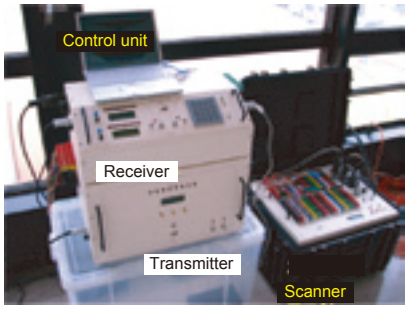
Jinguuji et al. (2007) Development of multi-transmission high-speed resistivity survey system. Expanded Abstracts, SEG 77th Annual International Meeting, San Antonio, USA

【Applications】

This device could be used in a wide range of construction and environment-related applications: high-density 3D electrical exploration can be used to evaluate the soundness of house foundations and to survey soil contamination, industrial waste disposal sites, and groundwater flow; and high-speed resistivity monitoring can be used to evaluate potential landslide sites, soundness of levees, and subsurface changes caused by air injection method.



Comparison of conceptual diagrams of the measurements between (a) conventional single transmission system and (b) the new multi-transmission system. Red circles are current electrodes and blue circles are potential electrodes. Different colors of the lines between current and potential electrodes indicate different frequencies.
The new device enables high-speed data acquisition through the simultaneous transmission of multiple currents of different frequencies and high sensitive signal separation using synchronous detection technology.



The new developed prototype can simultaneously transmit 8 channels and separate 64 mixed signals from received each potential electrodes channels, and enabling fast data acquisition of 1,200 data items per minute.

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Technology Transfer and Research Support for the Management of Water Resources in Southeast Asian Countries

Groundwater RG

【Outline】

GREEN has implemented research support and other projects as technology transfer and research assistance activities for resource management in Southeast Asia. In FY2008, we wrapped up the first phase (4 years) of the CCOP Groundwater Project and held the 8th Asian Geothermal Symposium.

(top) CCOP Final Results Meeting
(bottom) 8th Asian Geothermal Symposium participants

【Details】

CCOP Groundwater Project

In the first phase of this project, launched in 2005, participants surveyed groundwater-related laws of relevant countries and examined the current status of groundwater management and response to related issues. Participants also discussed land subsidence issues and groundwater management and monitoring methods, and reaffirmed the importance of groundwater management. Measures implemented in the past to counter land subsidence and other groundwater-related issues in Japan were also recognized as holding potential for Southeast Asian countries too.

【Applications】

8th Asian Geothermal Symposium

GREEN held the 8th Asian Geothermal Symposium (AGS) in Hanoi, Vietnam on 9–12 December 2008 on the theme of "Geothermal Energy: Emerging Issues and its Role in Energy Security and Environmental Protection for Asia". The symposium attracted considerably more general participants than previous AGS, including participants from Europe that gave the event a truly cosmopolitan atmosphere.

The symposium served to demonstrate the keen interest in geothermal issues among Southeast Asian nations and to reaffirm the importance of international cooperation. AGS, which GREEN has hosted almost every other year since 2003, is clearly growing in stature as an international symposium, and the 8th AGS demonstrated the importance of continuing such activities.

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New turning towards the development stage of the hot spring power generation system

Muraoka,H., Sasaki,M., Yanagisawa,N., Geothermal Resources RG

【Outline】

The Geothermal Resources Research Group has developed a hot spring power generation business model that makes use of surplus energy contained in hot spring water that is too hot to use as it is for bathing. In partnership with Geothermal Energy Research & Development Co., Ltd., the Group has submitted this model to NEDO's New Energy Venture Business Technology Innovation Program. Following a Phase I feasibility study in FY2007, full development is now underway in the FY2008–9 Phase II.

【Details】

If development of the 50kW Kalina cycle generation system* goes according to plan, it could be applied to hydrothermal resources distributed over 22% of Japan to generate an estimated power output of 8,330MW. We have tested the efficacy of various techniques for preventing hot spring precipitates from clogging heat exchangers, including cyclonic separation, CO_2 injection, electrolysis, and precipitate inhibitors, and the issue is now to identify the most economical combination of methods.

* A binary cycle power generation system that uses a working fluid composed of water and ammonia to drive a turbine and generate electricity even from hot water of under 100°C

Muraoka, H., Sasaki, M., Yanagisawa, N. and Osato, K. (2008) Development of a small and low-temperature geothermal power generation system and its marketability in Asia. Proceedings of the 8th Asian Geothermal Symposium (CD-ROM), 10p.

【Applications】

Because of the presence of far greater quantities of geothermal resources at the lower end of the temperature scale, this power generation technology could be used not only in Japan's many hot springs, but also overseas in the many countries with low to medium temperature geothermal zones that so far have not been open to exploitation for power generation. This is, moreover, a very compact geothermal power generation system that could be applied also to low demand localities.

Photo 1: Prototype cyclonic separator that successfully separated ferrihydrite

Photo 2: Prototype see-through CO_2 injection device. Our experiments demonstrated the efficacy of CO_2 injection in inhibiting calcium carbonate mineral precipitation through lowering pH

Photo 3: Electrolysis device collecting precipitates. In 10 days, the device collected 46g of calcium carbonate minerals.

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

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Research Group

- Geothermal Resources Research Group
- Fuel Resource Geology Research Group
- Mineral Resources Research Group
- Exploration Geophysics Research Group
- Geo-analysis Research Group
- CO_2 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 Evironment are carried out at two locations: Tsukuba Central 7 and Tsukuba West.